Channel Master

Horizontal ADCP

Operation Manual

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P/N 95B-6001-00 (February 2006)

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NOTES

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Channel Master Operation Manual

1 Introduction

Thank you for purchasing the RD Instruments (RDI) Channel Master Horizontal Acoustic Doppler Current Profiler.

Channel Master deployments are most often Real-Time. Real-Time use refers to the fact you are viewing the data as the Channel Master collects it via a personal computer. This data is also stored on the computer to allow for data playback and processing at a later time.

NOTE. When you receive your Channel Master, review the Channel Master Quick Start Guide to see all of the pieces you should have in your box. If anything is missing or damaged, contact RD Instruments immediately.

NOTE. When an addition or correction to the manual is needed, an Interim Change Notice (ICN) will be posted to our web site on the Customer Service page (www.rdinstrument.com). Please check our web site often.

NOTE. Click http://www.rdinstruments.com/smartlink/cm/index.shtml to get the latest documentation changes, Field Service Bulletins, FAQ's, and Product News!

1.1 Channel Master Applications

The Channel Master provides customers with reliable and repeatable measurements of the horizontal current profile across a body of water at a set depth, and displays the results through its user-friendly *WinHADCP* software. For detailed information on how to use *WinHADCP*, see the *WinHADCP* User's Guide.

Table 1: Channel Master Application Guide

Estuaries/River
Channel Master using WinHADCP
• Horizontal current profiles velocity vs. range • Suspended sediment load estimation • Discharge Monitoring

1.2 Getting Started

You are probably eager to get started, but take a moment to read a few words of guidance. We strongly recommend you read *all* of the provided documentation to learn the full capabilities of your Channel Master.

All documentation is being provided to you on CD in a fully searchable, printable, electronic format. This way, information is always available, whether you are at the office or in the field, and the electronic format is an environmentally friendly way to provide a large set of technical manuals. The documentation for each software program is located on the software program's CD.

To purchase a printed copy of the system documentation (includes the Channel Master Operation Manual and software guides), contact our Customer Service department at rdifs@rdinstruments.com or call (858)-693-1178 and order the Channel Master Manual kit (P/N 75BK6000).

1.3 Conventions Used in Manuals

Conventions used in the Channel Master documentation have been established to help you learn how to use the Channel Master quickly and easily.

Windows menu items are printed in bold: **File** menu, **Collect Data**. Items that need to be typed by the user or keys to press will be shown as **F1**. If a key combination were joined with a plus sign (**ALT+F**), you would press and hold the first key while you press the second key. Words printed in italics include program names (*BBTalk*) and file names (*default.txt*).

Code or sample files are printed using a fixed font. Here is an example:

```
Horizontal ADCP
RD Instruments (c) 2005
All rights reserved.
Product Version: CM02.04
>?
```

You will find three other visual aids that help you.

NOTE. This paragraph format indicates additional information that may help you avoid problems or that should be considered in using the described features.

CAUTION. This paragraph format warns the reader of hazardous procedures (for example, activities that may cause loss of data or damage to the Channel Master).

Recommended Setting. This paragraph format indicates additional information that may help you set command parameters.

2 System Overview

The Channel Master is designed to measure real-time horizontal current profiles from a permanent fixed mount. The Channel Master system consists of a Channel Master Horizontal ADCP, cables, and software. The input power requirements for the Channel Master are +10 to 18 VDC. The Channel Master system requires the addition of a Windows® compatible computer to collect data.

2.1 Inventory

You should have the following items

- Channel Master Horizontal ADCP
- I/O cable (the type of I/O cable sent depends on what Personality Module is installed – see Figure 12, page 20 and Figure 13, page 21)
- Channel Master Quick Start Guide
- Channel Master Documentation CD
- *WinHADCP* software CD
- *RDI Tools* software CD
- Tools and Spare Parts kit
- Shipping crate (please save all foam for reshipping use)
- Stainless Steel Mounting Plate and hardware

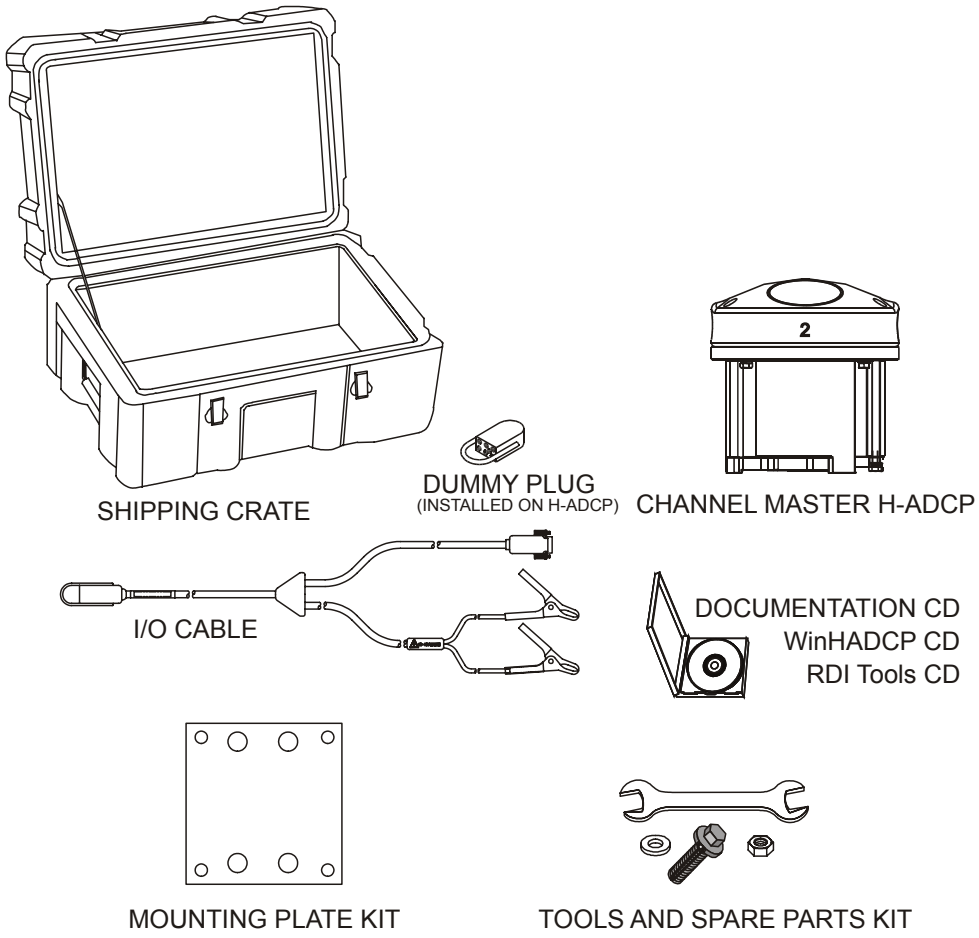


Figure 1. Channel Master Inventory

2.2 Visual Inspection of the Channel Master

Inspect the Channel Master using Table 2 and Figure 2, page 6 through Figure 4, page 7. If you find any discrepancies, call RDI for instructions.

Table 2: Visual Inspection Criteria

Item	Inspection Criteria
Channel Master H-ADCP	Check the urethane faces. There should be no gouges, dents, scrapes, or peeling.
I/O connector	Check the I/O connector for cracks or bent pins.
I/O Cable	Check the cable connectors for cracks or bent pins.

2.3 Channel Master Overview

The Channel Master instrument contains two horizontal and one vertical transducer ceramics and the electronics. The standard acoustic frequencies for the horizontal transducers are 1200 kHz, 600 kHz, and 300 kHz. The standard frequency for the vertical beam is 600 kHz. See "Outline Installation Drawings," page 134 for dimensions and weights.

I/O Cable Connector – Input/Output (I/O) cable connects the Channel Master to the computer.

Urethane Face – The urethane face covers the transducer ceramics. Never set the transducer faces on a hard/rough surface. The urethane faces may be damaged.

Housing – The standard housing allows deployment depths to 200M.

Thermistor – The Thermistor measures the water temperature.

Pressure Sensor (depth) – The pressure sensor measures water pressure.

Tilt Sensor – The internal tilt sensor measures pitch and roll of the Channel Master.

Transducer Head – The electronics and transducer ceramics are mounted to the transducer head.

NOTE. The Channel Master uses X-Y Instrument Coordinates. The positive X direction is from transducer Beam 2 to transducer Beam 1. The Y-axis is perpendicular to the X-axis (see Figure 22, page 45).

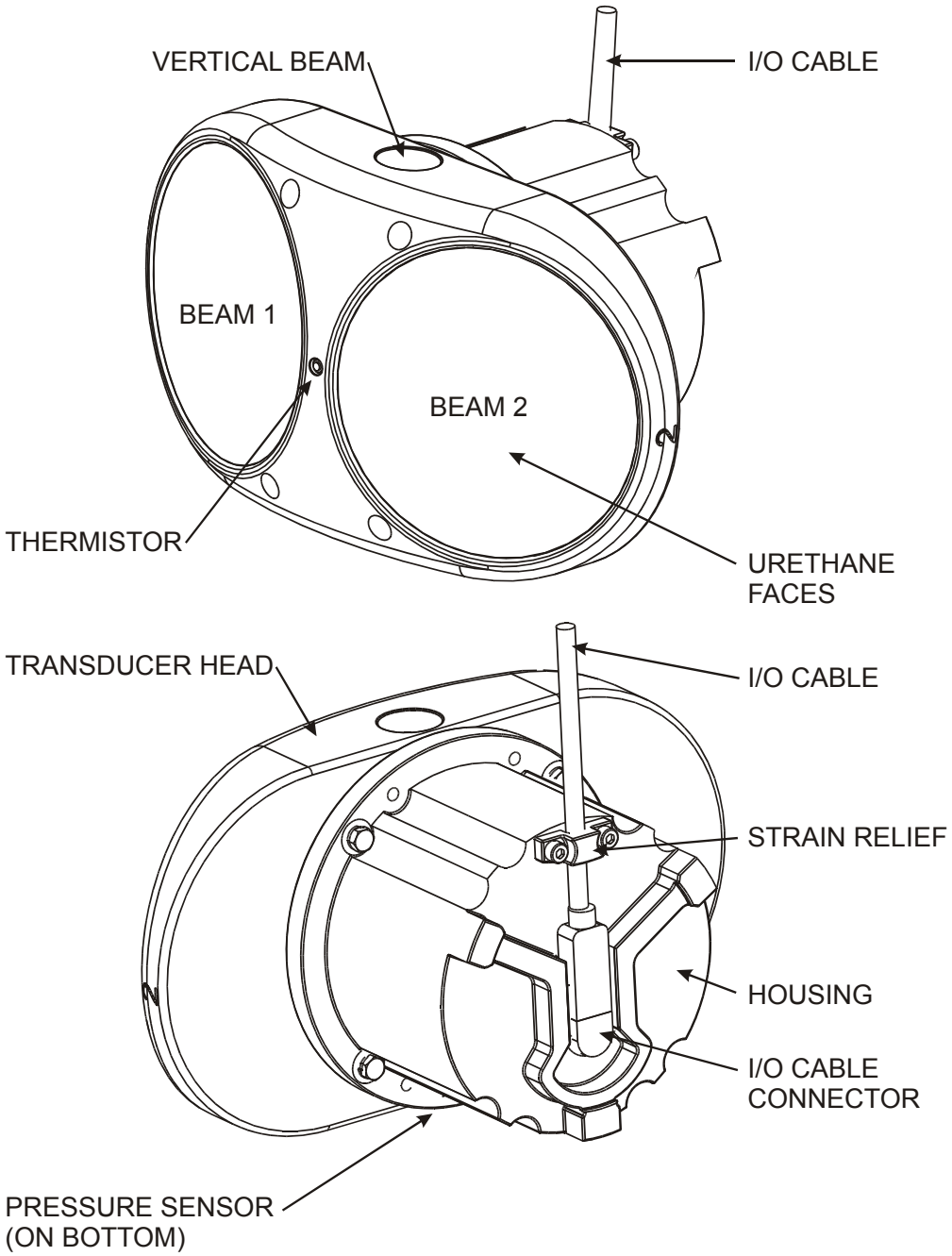


Figure 2. Channel Master (300 kHz) Overview

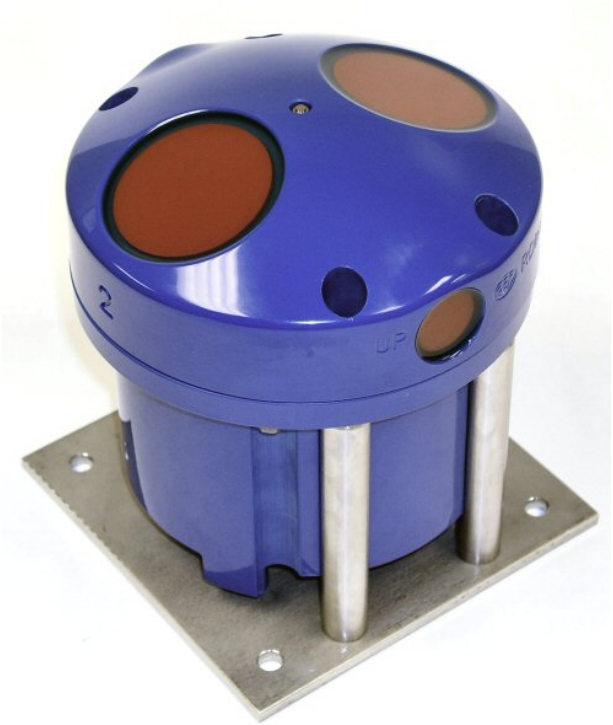


Figure 3. Channel Master Transducer (1200 kHz) with Mounting Plate

Figure 4. Channel Master Housing View

3 Channel Master Care

This section contains a list of items you should be aware of every time you handle, use, or deploy your Channel Master. *Please refer to this list often*.

3.1 General Handling Guidelines

- Never set the Channel Master on a hard or rough surface. **The urethane faces may be damaged.**
- Always remove the retaining strap on the end-cap underwater-connect cable and dummy plug when disconnecting them. **Failure to do so will break the retainer strap.**
- Disconnect the I/O cable by pulling it off in a straight in-line motion. **Stressing the end-cap connector may cause the Channel Master to flood.**
- Do not expose the transducer faces to prolonged sunlight. **The urethane faces may develop cracks.** Cover the transducer faces on the Channel Master if it will be exposed to sunlight.
- Do not expose the I/O connector to prolonged sunlight. **The plastic may become brittle.** Cover the connector on the Channel Master if it will be exposed to sunlight.
- Do not store the Channel Master in temperatures over 75 degrees C. **The urethane faces may be damaged.** Check the temperature indicator inside the shipping case. It changes color if the temperature limit is exceeded.
- Do not scratch or damage the O-ring surfaces or grooves. **If scratches or damage exists, they may provide a leakage path and cause the Channel Master to flood.** Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support a Channel Master by the external I/O cable. **The connector or cable will break.**

3.2 Assembly Guidelines

- Read the Maintenance section for details on Channel Master re-assembly. Make sure the housing assembly O-rings stay in their groove when you re-assemble the Channel Master. Tighten the hardware as specified. **Loose, missing, stripped hardware, or damaged O-rings can lead to water ingress and damage to the Channel Master.**

- The Channel Master uses Titanium hardware for the transducer housing and strain relief. These hardware sets are expensive and difficult to purchase locally. **Don't loose or substitute other metal hardware.**
- Place a light amount of DC-111 lubricant on the end-cap connector pins (rubber portion only). **This will make it easier to connect or remove the I/O cable and dummy plug.**
- Do not connect or disconnect the I/O cable with power applied. When you connect the cable with power applied, you may see a small spark. **The connector pins may become pitted and worn.**
- The I/O cable is *wet* mate-able, not *underwater* mate-able.

3.3 Deployment Guidelines

- Read the Channel Master Quick Start Guide and the Software User's Guides. **These guides have tutorials to help you learn how to use the Channel Master.**
- The instrument should be electrically isolated from any mounting structure to avoid electrolysis problems.

4 Setup the Channel Master

Figure 5 through Figure 7, page 11 illustrates how to connect the Channel Master cable to your computer and power. Make sure the Channel Master is resting with the vertical beam facing upward or on its housing end to protect the I/O cable connector and the transducer urethane faces.

Channel Master units are pre-configured to use RS-232, RS-422, or SDI-12 communications protocols. Your computer's communication port must match the Channel Master, or use an adapter. To change the communication protocol, see "Personality Module Replacement," page 32.

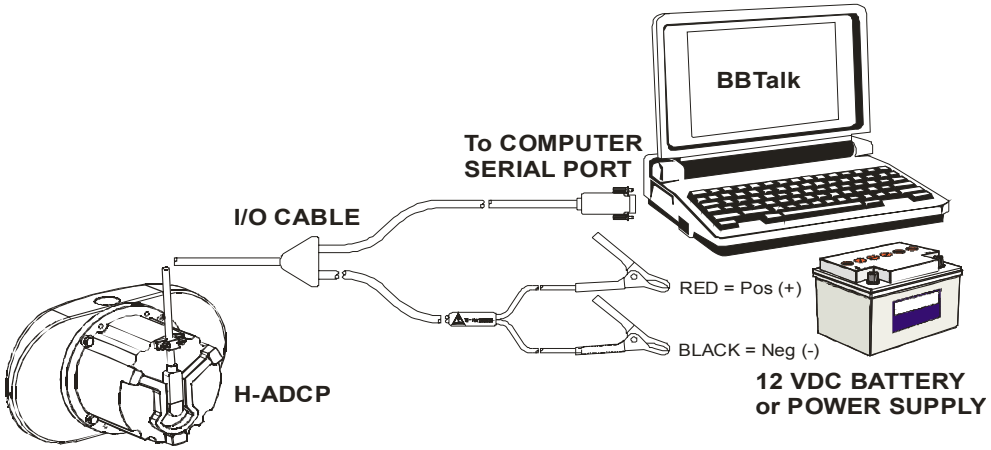


Figure 5. Channel Master Connections with RS-232

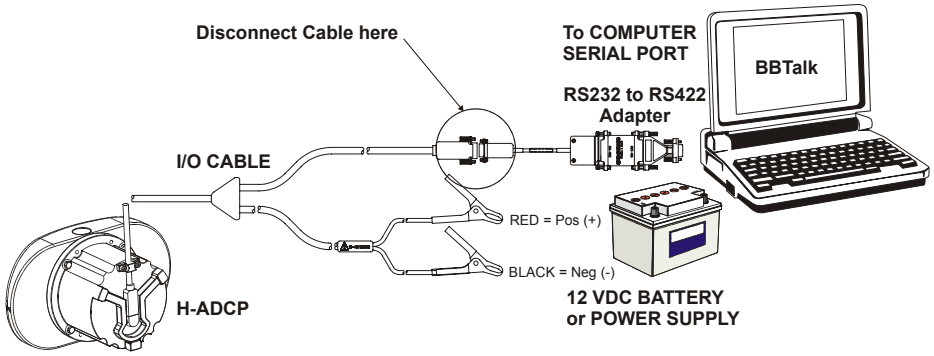


Figure 6. Channel Master Connections with RS-232 to RS-422 Adapter

NOTE. If you ordered the RS-422 configuration, the Channel Master is supplied with a RS-232 to RS-422 converter. The RS-232 to RS-422 converter must be disconnected from the Channel Master when the cable has been disconnected from the computer. If left connected, the internal battery used to maintain ROM inside the Channel Master can be drained or false Breaks may be sent.

NOTE. The RS-232 to RS-422 converter supplied with the Channel Master is powered by the computer's COM port. It may be necessary to use a different converter when very long communication lines are used (maximum 1300 meters).

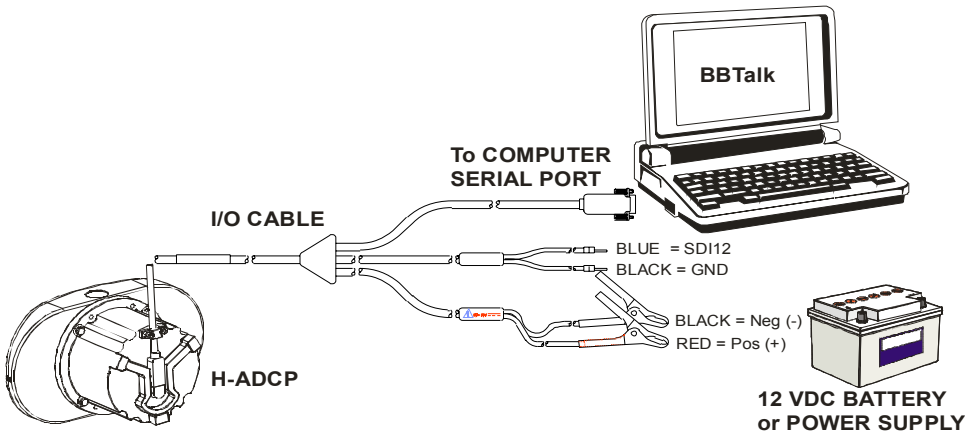


Figure 7. Channel Master Connections with SDI12

4.1 Power Requirements

The Channel Master requires a DC supply between 10 volts and 18 volts. Either an external DC power supply or battery can provide this power. If you are using a battery, use the largest rated amp-hour battery as possible. A fully charged 48Ah battery should last five days powering a 600-kHz Channel Master.

NOTE. Check that the battery voltage is above 10 Volts DC. Channel Masters will work at 10 volts; however, batteries with voltages below 11 volts are at or near their end of life and are approaching uselessness.

4.2 What if the Channel Master Does Not Respond

If your Channel Master does not respond, check the following items.

a. Is the I/O cable connected from your computer's COM port to the Channel Master?

b. Is power connected to the Channel Master I/O Cable?

c. Check the communication setup using *BBTalk*. See the RDI Tools User's Guide for detailed help on using *BBTalk*. The computer and the Channel Master must be using the same baud rate and COM port.

d. If wakeup still does not occur, contact RD Instruments.

5 Software

RDI has utility programs to help you set up, use, test, and trouble-shoot your Channel Master. Each program has a help file that you can print, or you can view help while running the program.

Table 3: Channel Master Software Main Modules

Program Name	Description
BBTalk	Windows Channel Master communication program. Use this program to "talk" to the Channel Master and to run test script files. *BBTalk* is included on the RDI Tools CD. For detailed information on how to use *BBTalk*, see the *RDI Tools User's Guide*.
WinHADCP	Windows *WinHADCP* software is used for data acquisition, data display and data archiving. It is recommended to use the default settings supplied by RD Instruments. For detailed information on how to use *WinHADCP*, see the *WinHADCP User's Guide*.
Documentation CD	The Documentation CD has an Adobe Acrobat® (*.pdf) electronic version of the Channel Master Technical Manual. Use the Documentation CD to search for information.

5.1 System Requirements

The Channel Master software requires the following:

- Windows 95®, Windows 98®, or Windows® NT 4.0 with Service Pack 4 installed, Windows 2000®, Windows XP®
- Pentium class PC 233 MHz (350 MHz or higher recommended)
- 32 megabytes of RAM (64 MB RAM recommended)
- 6 MB Free Disk Space (20 MB recommended)
- One Serial Port (two High Speed UART Serial Ports recommended)
- Minimum display resolution of 800 x 600, 256 color (1024 x 768 recommended)

5.2 Software Installation

To install the Channel Master software, do the following.

a. Insert the compact disc into your CD-ROM drive and then follow the browser instructions on your screen. If the browser does not appear, complete Steps “b” through “d.”

b. Click the **Start** button, and then click **Run**.

c. Type **<drive>:launch**. For example, if your CD-ROM drive is drive D, type **d:launch**.

d. Follow the browser instructions on your screen

6 Testing Your Channel Master

Use the following steps to test the Channel Master.

a. Interconnect and apply power to the system as described in "Setup the Channel Master," page 10.

b. Start the *BBTalk* program (for help on using *BBTalk*, see the RDI Tools User's Guide).

c. On the **File** menu, click **Break** (you can also press the **End** key to send a break or use the Toolbar and press the **B** button). You should see the wakeup message appear on the log file window.

```
Horizontal ADCP
RD Instruments (c) 2005
All rights reserved.
Product Version: CM02.04

>
```

d. At the ">" prompt in the communication window, enter the direct command **CR1** then press the **Enter** key. This will set the Channel Master to the factory default settings.

e. At the ">" prompt in the communication window, enter the direct command **CK** then press the **Enter** key. This will save the factory default setting.

f. At the ">" prompt in the communication window, enter the direct command **PS0** then press the **Enter** key. This will display the Channel Master system configuration data.

```
>PS0
   Serial Number:  5813
       Frequency:  1228800 Hz
   Configuration:  HADCP: 2-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  TEMP  PRESS  TILTS

 Product Version:  CM02.04
    CPU Firmware:  28.28f
    FPGA Version:  2.00.003
     Sensor Boot:  32.02
 Sensor Firmware:  33.03

Board Serial Number Data:
 24 00 00 00 32 23 40 23   SNS72B-1000-00A
 15 00 00 00 31 65 DC 23   PIO72B-2001-00B
 A8 00 00 00 10 66 B6 23   XDR71B-1007-00A
 E3 00 00 00 1F CD 99 23   PER72B-2006-00X
 DC 00 00 00 31 CA 43 23   RCV72B-2003-09A
 90 00 00 00 31 AB 7F 23   DSP72B-2002-00A
>
```

g. At the “>” prompt in the communication window, enter the direct command **PA** then press the **Enter** key. This will run the Channel Master Pre-Deployment test.

```
>PA
RAM test..........PASS
GO
>
```

h. If the wakeup, PS0 and PA message display, the Channel Master is functioning normally.

7 Recovering Data from the Loop Recorder

The loop recorder contains approximately two megabytes of solid-state nonvolatile memory, which can be used to continuously record data. If more data is collected than fits in the memory, the oldest data will be over-written with the newest data. You always have up to the last two megabytes of data available for download.

7.1 Using WinHADCP to Recover Data

a. On the **Tools** menu, click **Recover CM Recorder**.

b. Select the folder where the files will be downloaded. Click **OK**.

c. When the download is complete, click **OK**.

7.2 Using BBTalk to Recover Data

Use *BBTalk* to recover data from the loop recorder.

NOTE. You must use *BBTalk* version 3.04 or greater. Older versions of *BBTalk* do not have the Loop Recorder functions.

a. Start *BBTalk*. Configure *BBTalk* to connect to a Channel Master ADCP type device (see the RDI Tools User's Guide for details on using *BBTalk*).

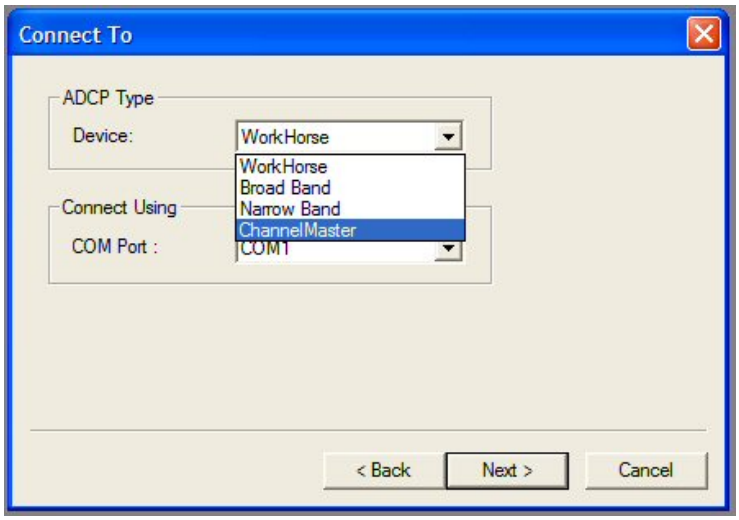


Figure 8. Connecting to the Channel Master with BBTalk

CAUTION. Make sure you select **Channel Master** as the **Device**. *BBTalk* will communicate with the Channel Master if you select **WorkHorse** as the device, but will not be able to recover the recorder.

b. On the **File** menu, click **Recover Loop Recorder**.

c. Enter the directory where the files will be downloaded. Click the "…" button to browse for the directory. Click **OK**.

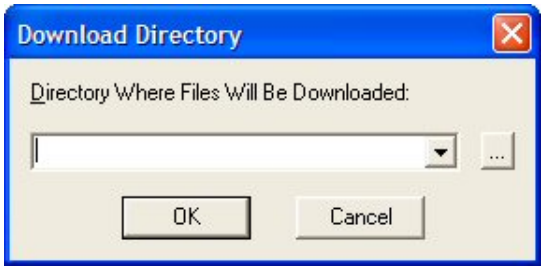


Figure 9. Download Directory

d. *BBTalk* displays current protocol status, filename being received, total size of receiving file and current number of bytes received.

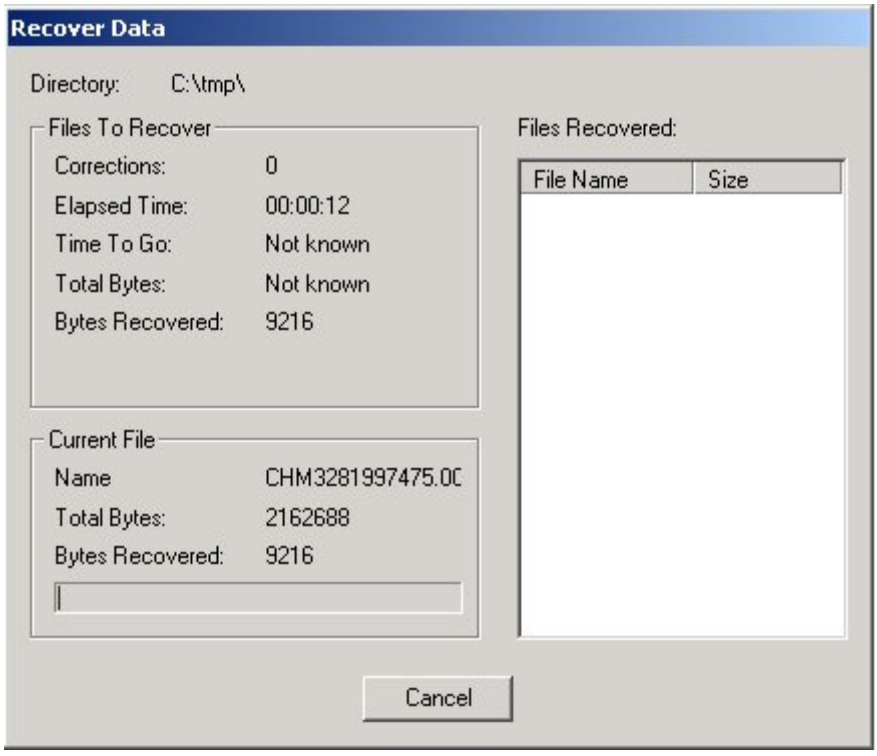


Figure 10. Recover Loop Recorder

8 Channel Master Maintenance

This section explains how to prepare the Channel Master for deployment, how to do certain maintenance, and how to prepare the Channel Master for storage or shipment.

8.1 Spare Parts

The following parts are included in the spare parts kit.

Table 4: Spare Parts

Description	Part number
O-ring, face	2-254
Desiccant, sealed bag	DES3
Lubricant, silicone, 4-pack	5020
Kit, fill, silicone oil	75BK6004-00
Copper screw	817-1067-00
Washer, 6mm Split Lock SST316	M6WASHSPL
Washer, 6mm Split Lock Titanium	M6WASHSPLTI
Washer, Flat, 12.5MMOD, Titanium	M6WASHSTDTI
Washer, Flat, 12.5MMOD, SST316	M6WASHSTD
Screw, Flat Head, Socket Head, SST 18-18	M6X1.0X16FHSH
Screw, Titanium	M6x1.0x16HHTI
Screw, Titanium	M6X1.0X25HHTI
Screw, Hex Head, SST 18-8	M6X1.0X35HH

8.2 I/O Cable and Dummy Plug

The I/O cable connector (on the Channel Master housing) and the I/O cable and dummy plug are molded wet-mate connectors. The I/O cable connector is a factory-installed item. We do not recommend removing it for any routine maintenance.

NOTE. The dummy plug should be installed any time the I/O cable is removed. Use the dummy plug when the Channel Master is in storage or is being handled.

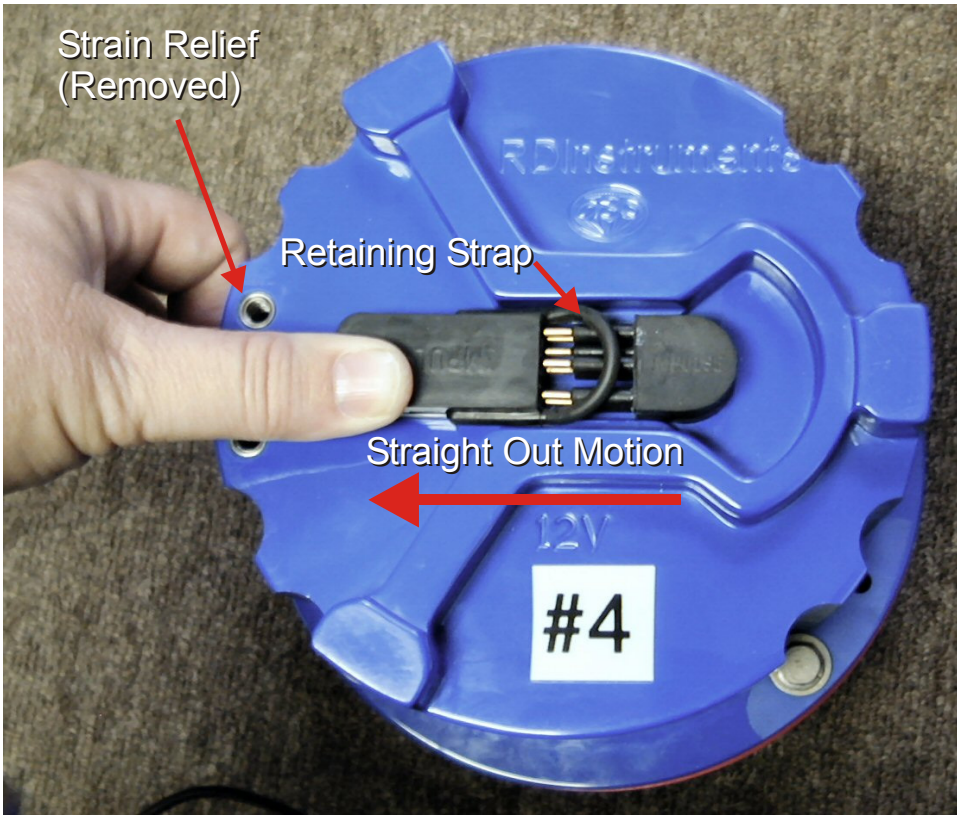


Figure 11. Connecting and Disconnecting the I/O Cable

8.2.1 Disconnecting the I/O Cable or Dummy Plug

The I/O cable should be disconnected with a straight outward motion only. Use the following procedure to disconnect the cable.

> **CAUTION.** When disconnecting the Channel Master I/O cable, do not apply any upward force on the connector as it is being pulled off. Applying an upward angle as the cable is disconnected puts stress on the end-cap connector. This may cause several serious problems: a) The housing connector or connector pins can crack. b) The O-ring on the bottom of the housing connector can be damaged. c) The molded urethane on the housing connector may separate from the brass insert. **If the housing connector is damaged in any of these ways, your Channel Master will flood.**

a. Remove the strain relief. Save all hardware.

b. Release the retaining strap by pulling it over the connector.

> **CAUTION.** Failure to release the retaining strap before removing the cable will break the retainer strap.

c. Grasp the cable close to the housing (see Figure 11, page 18). Your thumb should rest on top of the connector or against the edge of the housing. *Do not try to fit your hand under the cable as it passes over the housing*. This is what causes the upward force!

d. Pull the cable straight out away from the housing with a gentle side-to-side rocking motion. Do not apply any upward force on the connector as it is being disconnected.

e. Install the dummy plug to protect the I/O cable connector pins.

8.2.2 Connecting the I/O Cable or Dummy Plug

The cable should be connected with a straight inward motion only. Use the following procedure to connect the cable.

a. Apply a light coat of DC-111 lubricant to the rubber portion of the housing I/O cable connector pins. This will help seat the connector.

b. Gently push the cable or dummy plug straight in toward the housing connector. Do not apply any upward force on the connector as it is being connected.

c. Roll the retaining strap over the connector.

d. Install the strain relief.

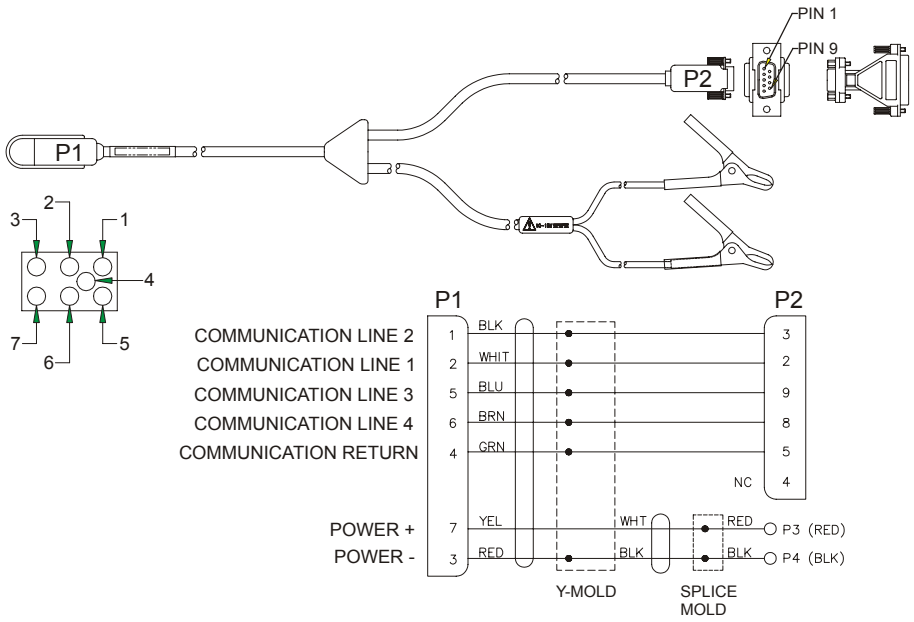


Figure 12. RS232/RS422 I/O Cable Overview and Wiring Diagram

Communication lines 1 through 4 signal names depend on what personality module is installed. Use the following tables to identify the signal name.

Table 5: RS232 Personality Module (P/N 72B2006)

Communication Line	Signal Name
Comm1	TX1 232
Comm2	RX1 232
Comm3	RS485A
Comm4	RS485B

Table 6: RS422 Personality Module (P/N 72B2008)

Communication Line	Signal Name
Comm1	RS422TB
Comm2	RS422TA
Comm3	RS422RA
Comm4	RS422RB

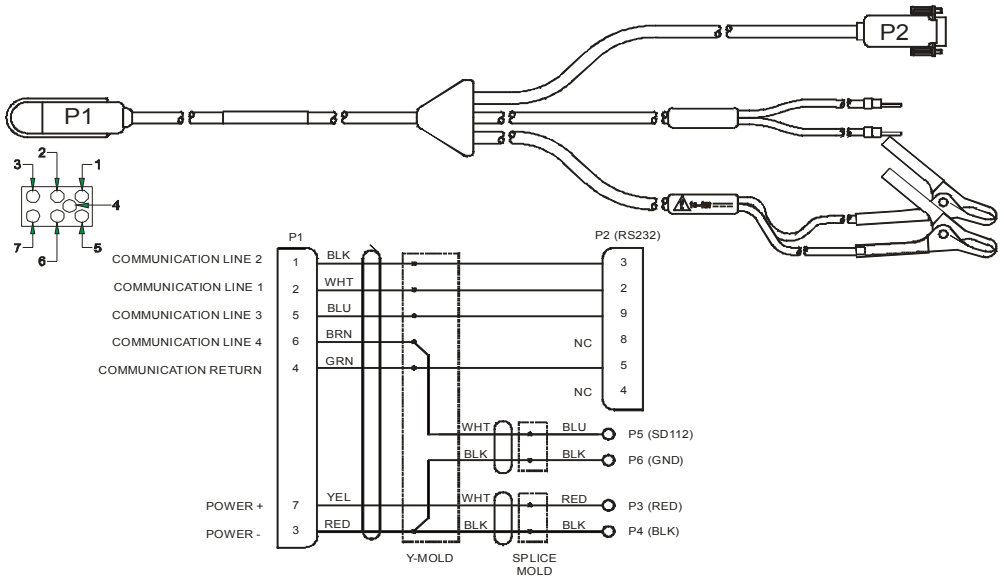


Figure 13. SDI-12 I/O Cable Overview and Wiring Diagram

Communication lines 1 through 4 signal names depend on what personality module is installed. Use the following table to identify the signal name.

Table 7: SDI-12 Personality Module (P/N 72B 2005)

Communication Line	Signal Name
Comm1	TX1 232
Comm2	RX1 232
Comm3	TRIG IN
Comm4	SDI12

8.3 Housing Assembly Removal

a. Remove all power to the Channel Master.

b. Remove the I/O cable and place the dummy plug on the I/O cable connector (see "I/O Cable and Dummy Plug," page 18).

c. Set the transducer assembly (transducer face down) on a soft pad.

d. Loosen (do not remove) the four titanium bolts (M6) bolts to vent the system.

e. Once all four bolts have been loosened, remove the four bolts that attach the housing flange to the transducer head assembly.

f. Carefully lift the housing assembly straight up and away from the transducer assembly until you can gain access to the connector jack on the top PC board (see Figure 14). Use care; the plastic mating surfaces scratch easily. Do not damage the mating surfaces.

g. Squeeze the sides of the internal I/O cable connector to release it from the jack (see Figure 15, page 23). Set the housing assembly aside.

Figure 14. Removing the Housing

NOTE. The cable attached to the housing is only long enough to disconnect the internal I/O cable. There is NOT enough cable to set the housing down next to the transducer Assembly.

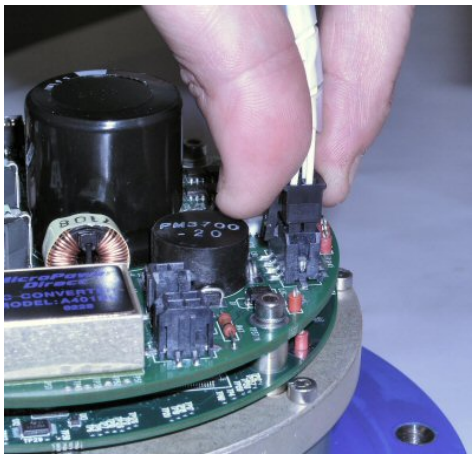


Figure 15. Disconnecting the Internal I/O Cable

h. Clean the O-ring mating surfaces with a soft, lint-free cloth. Inspect the surfaces for damage (see "O-Ring Inspection and Replacement," page 25).

i. When you are ready to re-assemble the Channel Master, see "Channel Master Re-assembly," page 25.

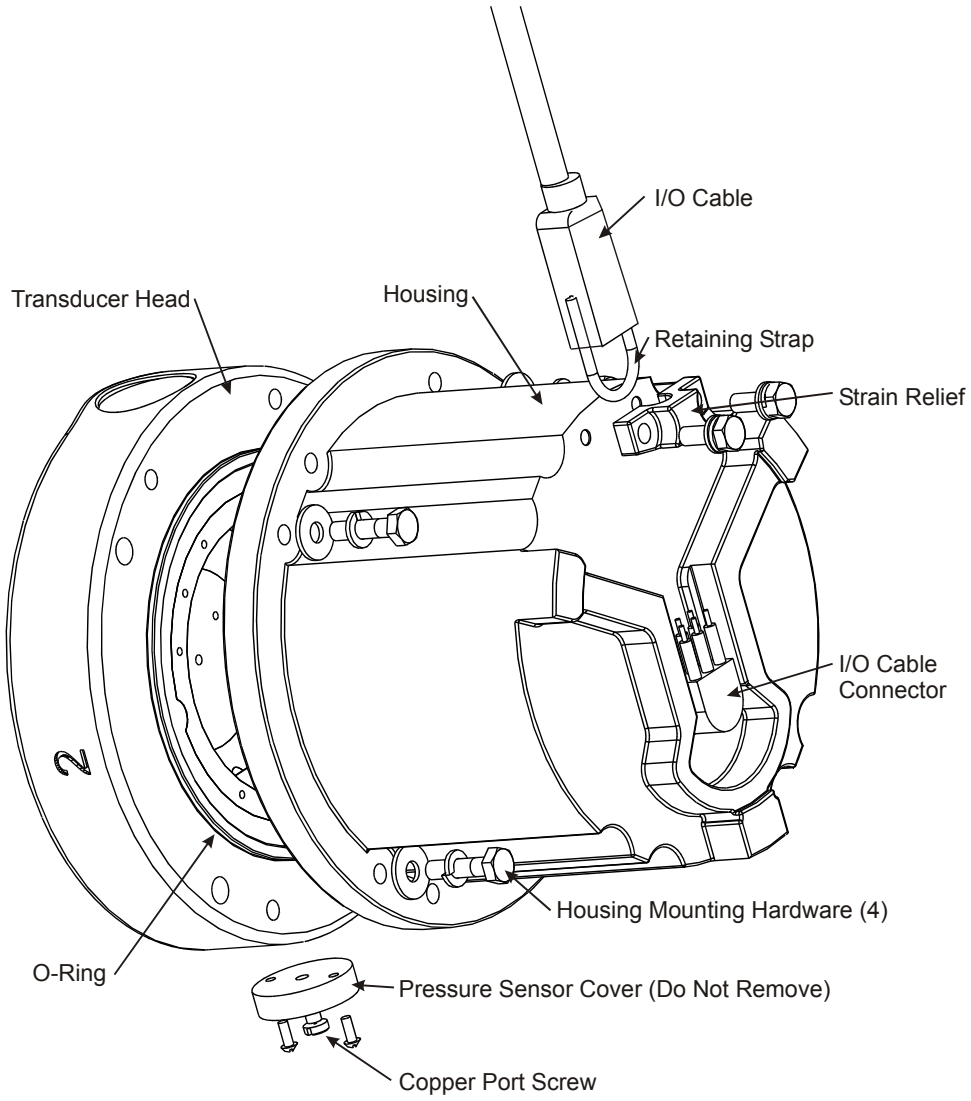


Figure 16. Channel Master Assembly

8.4 Channel Master Re-assembly

To replace the housing, proceed as follows. Use Figure 16, page 24 for parts identification.

8.4.1 O-Ring Inspection and Replacement

This section explains how to inspect/replace the Channel Master O-ring. A successful deployment depends on the condition of O-ring and the retaining groove. See Figure 16, page 24 for the location of the O-ring. Read all instructions before doing the required actions.

We strongly recommend replacing the O-ring whenever you disassemble the Channel Master. Inspecting and replacing the O-ring should be the last maintenance task done before sealing the Channel Master.

NOTE. We recommend you use new O-rings if you are preparing for a deployment.

a. Inspect the O-ring. When viewed with an unaided eye, the O-ring must be free of cuts, indentations, abrasions, foreign matter, and flow marks. The O-ring must be smooth and uniform in appearance. Defects must be less then 0.1 mm (0.004 in.).

CAUTION. If the O-ring appears compressed from prior use, replace it. **Weak or damaged O-rings will cause the Channel Master to flood.**

b. Clean and inspect the O-ring groove. Be sure the groove is free of foreign matter, scratches, indentations, corrosion, and pitting. Run your fingernail across damaged areas. If you cannot feel the defect, the damage may be minor; otherwise, the damage may need repair.

CAUTION. Check the O-ring groove thoroughly. **Any foreign matter in the O-ring groove will cause the Channel Master to flood.**

c. If a scratch is on the plastic housing flange O-ring groove, it may be gently sanded using 600-grit (wet) sandpaper. Use care not to cause further damage.

d. Lubricate the O-ring with a thin coat of DC-111 lubricant. Apply the lubricant using latex gloves. Do not let loose fibers or lint stick to the O-ring. Fibers can provide a leakage path.

NOTE. RDI uses Dow Corning's silicone lube model number 111 but any type of silicone O-ring lube can be used.

CAUTION. Apply a **very thin** coat of silicone lube on the O-ring. Using too much silicone lube on the O-ring can be more harmful than using no O-ring lube at all.

8.4.2 Housing Assembly Replacement

a. Set the Housing assembly on its end on a soft pad.

b. Make sure all printed circuit boards, spacers, cables, and screws have been installed.

c. Inspect, clean, and lubricate the O-ring on the housing (see "O-Ring Inspection and Replacement," page 25).

> **CAUTION.** Follow all the steps for O-Ring Inspection and Replacement. The watertight integrity of the Channel Master depends on this seal.

d. Connect the internal I/O connector to the plug on the top PC Board.

e. Install two fresh bags of desiccant just before closing the Channel Master (see "Desiccant Bags," page 33).

f. Gently lower the transducer head assembly into the housing assembly, aligning the mating holes and the making sure that the I/O cable connector pins on the housing are facing the vertical beam on the transducer head. When mating the housing with the transducer head flange try to apply equal pressure to all parts of the O-ring. Make sure the face O-ring remains in the retaining groove.

> **CAUTION.** Check that no wires or any other object is pinched between the transducer head assembly and the housing. Use rubber bands to hold the wiring in place as necessary. **If the O-ring is not in the groove or if a wire or other object is pinched, the Channel Master will flood.**

> **NOTE.** Make sure the I/O cable connector pins are facing the vertical transducer beam.

g. Examine the titanium housing assembly bolts, split washer, and flat washers (M6) for corrosion: replace if necessary. Figure 16, page 24 shows the assembly order of the transducer mounting hardware. All hardware items are needed to seal the Channel Master properly.

h. Install all four sets of hardware but leave the housing hardware loose enough to not make an airtight seal. You should be able to see a gap between the housing and transducer head. Slide a small wedge (a folded piece of paper or credit card) between the housing and transducer head to maintain the gap. Be careful not to dislodge the O-ring from the O-ring groove.

8.4.3 Pressure Sensor Calibration and Close-up

a. Interconnect and apply power to the Channel Master as described in "Setup the Channel Master," page 10.

b. Start the *BBTalk* program (for help on using *BBTalk*, see the RDI Tools User's Guide).

c. On the **File** menu, click **Break** (you can also press the **End** key to send a break or use the Toolbar and press the **B** button). You should see the wakeup message appear on the log file window.

d. Leave the Channel Master powered up in a temperature-controlled area for at least one hour so that any temperature gradients within the system equalize.

e. At the > prompt, type **#sc**. The Channel Master will respond with:

```
>#sc
*** CAUTION: These commands are reserved for RDI use
and may not be currently supported!
Input local barometric pressure in inches of mercury:
```

f. Determine the barometric pressure at your location as accurately as possible. Use barometric pressure (what your barometer reads, or your wrist watch barometer reads), not an airport weather forecasting service altimeter reading that is corrected for sea level pressure.

   For example, a barometer reading is 2984. The numbers represent barometric pressure in hundredths of inches of mercury. Divide this number by 100 so that it represents barometric pressure in inches of mercury (e.g., 29.84inHg).

   International users may be given the barometric pressure in millibars (mb) or hectopascals (hPa). The barometric pressure must be entered in inches of mercury (inHg). To convert between inches of mercury (inHg) and millibars (mb) or hectopascals (hPa), use the formula $P_{inHg} = 0.0295300 \times P_{mb}$.

   For example, to convert 1013hPa to inches of mercury (inHg), multiply 1013 x 0.0295300 so that it represents barometric pressure in inches of mercury (e.g., 29.92inHg).

g. Enter this number in inches of mercury (inHg) at the prompt and press enter.

h. The Channel Master should respond with:

```
"Make sure the unit is open to ambient pressure. Hit any key to con-
tinue...".
```

i. Press any key to continue.

j. The Channel Master should respond with the following message.

```
"Now close the unit and tighten the closeup hardware. After this, hit any
key to continue...".
```

k. Remove any wedge between the housing and transducer head. Tighten the bolts in small increments in a "cross" pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 4 Newton-meters (34.4 pound-force inches).

CAUTION. Apply equal pressure to the O-ring as you tighten the bolts. If one bolt is tightened more then the others, the O-ring can become pinched or torn. **A damaged O-ring will cause the Channel Master to flood.**

CAUTION. Do not over tighten the bolts that hold the transducer and housing together. If you tighten too far, you can crack or break the plastic housing. On the other hand, leaving the bolts too loose can cause the system to flood. **Tighten the hardware to the recommended torque value.**

NOTE. The recommended torque value for the housing M6 bolts is 4 Nm (34.4 lbf in).

l. If the calibration was successful, the unit should respond with:

```
"SUCCESS: Close up calibration complete. Execute PC2 to verify."
```

m. At the > prompt, type **PC2** and press return. Verify that the pressure reported by the PC2 Press (kPa) column is approximately +/- 0.050 kPa.

```
Temp(degC)   Press(kPa)   Press(m) Pitch(deg) Roll(deg)
/    23.15      -0.009    -0.001       0.31      0.67
```

NOTE. After a few samples the pressure will begin to change as a result of changes in ATM pressure or interior building pressure. Verify the test results within the first 20 seconds.

n. At the > prompt, type **CZ** and press return. Verify the "**going to sleep**" message is present.

o. Exit *BBTalk* and turn off power to the Channel Master.

8.5 Firmware Upgrades

The Channel Master contains two processors (three if the SDI-12 personality module is present), each with two firmware modules. When new firmware is released, Teledyne RDI provides a firmware update package. The package contains *CMFlash*, all the firmware modules, and a readme file. It updates all out of date firmware to the latest version. The name of the update package may be *CMFRM!.EXE* or the name may contain a version number, such as *CMFlash_v0203.exe*.

NOTES.

The most recent firmware versions can be seen at Teledyne RDI's website. To see what versions a firmware package contains, see the readme file.

A standard firmware package will only upload newer firmware than what is already in the Channel Master.

The firmware versions in your Channel Master can be displayed with the PS0 command (see "PS0 – System Configuration," page 77).

Channel Master firmware packages may contain updates to one or more of the following: CPU firmware, FPGA firmware, Sensor Boot firmware, or Sensor firmware. In addition, they may include SDI-12 Boot firmware and SDI-12 firmware. These are for the optional SDI-12 personality module.

To update your firmware, run the firmware package as described below.

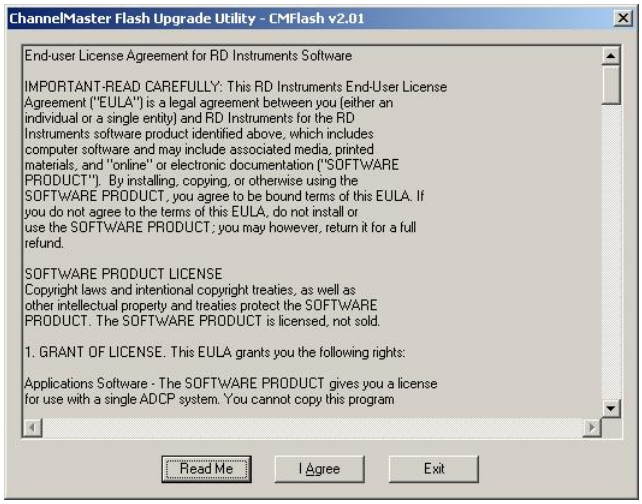
a. Interconnect and apply power to the Channel Master as described in "Setup the Channel Master," page 10.

b. Download or copy the firmware update file to your computer's hard drive (see "Technical Support," page 137 for contact information).

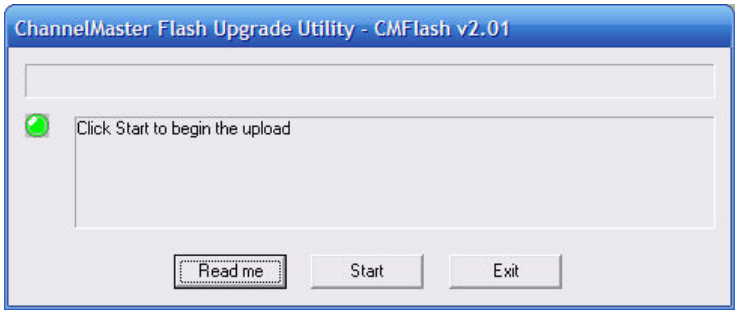
c. Double-click the *exe* file to begin. Click the **Setup** button when you are ready to begin the firmware update.

Figure 17. CMFlash Upgrade Utility Program

d. Click the **ReadMe** button to see what the changes are in the new firmware version. On the License page, click **I Agree** to continue.


ChannelMaster Flash Upgrade Utility - CMFlash v2.01
End-user License Agreement for RD Instruments Software
IMPORTANT-READ CAREFULLY: This RD Instruments End-User License Agreement ("EULA") is a legal agreement between you (either an individual or a single entity) and RD Instruments for the RD Instruments software product identified above, which includes computer software and may include associated media, printed materials, and "online" or electronic documentation ("SOFTWARE PRODUCT"). By installing, copying, or otherwise using the SOFTWARE PRODUCT, you agree to be bound terms of this EULA. If you do not agree to the terms of this EULA, do not install or use the SOFTWARE PRODUCT; you may however, return it for a full refund.
SOFTWARE PRODUCT LICENSE
Copyright laws and intentional copyright treaties, as well as other intellectual property and treaties protect the SOFTWARE PRODUCT. The SOFTWARE PRODUCT is licensed, not sold.
1. GRANT OF LICENSE. This EULA grants you the following rights:
Applications Software - The SOFTWARE PRODUCT gives you a license for use with a single ADCP system. You cannot copy this program
Read Me
I Agree
Exit

e. If you have not already read the *Read me* file, click the **Read me** button. Click **Start** to begin the firmware upgrade.

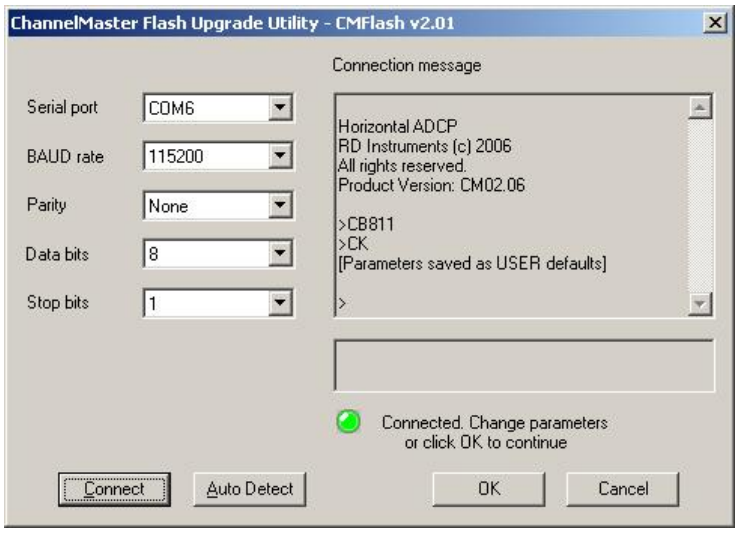


f. Select the Serial port your PC uses to communicate with the Channel Master.

NOTE. If you do not see this port listed, it may be in use by another program such as *WinHADCP* or *BBTalk*. If this happens, close the port and then close the firmware package and start it again.

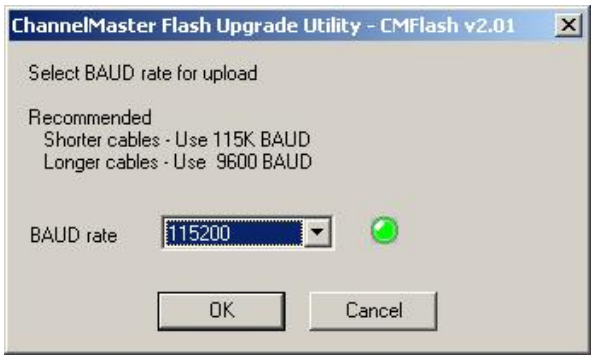
g. Select the BAUD rate your Channel Master uses when it wakes up. Parity, Data bits, and Stop bits are rarely changed from their default values, so leave them as they are.

h. Click **Connect**. If all is well, a wakeup banner will appear in the Connection message window and the indicator light will turn green. If this does not happen, try again with other settings or click **Auto Detect**. When the light is green, click **OK** to continue.

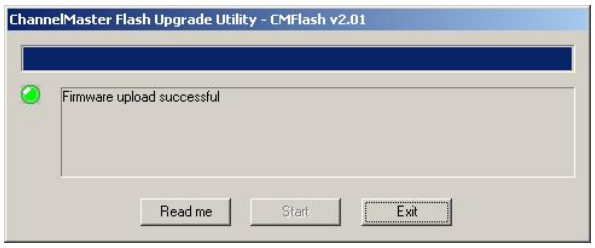


NOTE. Once the indicator light is green, you can change the communication settings. If you do, the new settings are sent to the Channel Master and saved with a CK command. They become the new wakeup settings.

i. Select the temporary **BAUD rate** to use for the firmware upgrade. The BAUD rate will be returned to the user default when done. Click **OK** to continue.



j. Wait for the **Firmware upload successful** message. Click **Exit**.



k. Start *BBTalk*. At the ">" prompt, type **PS0**. Verify the firmware versions have been updated.

```
Horizontal ADCP
RD Instruments (c) 2006
All rights reserved.
Product Version: CM02.04

>PS0
   Serial Number:  5813
       Frequency:  1228800 Hz
   Configuration:  HADCP: 2-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  TEMP  PRESS  TILTS

 Product Version:  CM02.04
    CPU Firmware:  28.28f
    FPGA Version:  2.00.003
     Sensor Boot:  32.02
 Sensor Firmware:  33.03

Board Serial Number Data:
 24 00 00 00 32 23 40 23   SNS72B-1000-00A
 15 00 00 00 31 65 DC 23   PIO72B-2001-00B
 A8 00 00 00 10 66 B6 23   XDR71B-1007-00A
 E3 00 00 00 1F CD 99 23   PER72B-2006-00X
 DC 00 00 00 31 CA 43 23   RCV72B-2003-09A
 90 00 00 00 31 AB 7F 23   DSP72B-2002-00A>
```

8.6 Personality Module Replacement

Personality modules can be replaced to change the Channel Master communications protocols (i.e. switch from RS-422 to RS-232).

a. Remove all power to the Channel Master.

b. Remove the I/O cable and place the dummy plug on the I/O cable connector (see "I/O Cable and Dummy Plug," page 18).

c. Set the transducer assembly (transducer face down) on a soft pad.

d. Remove the housing (see "Housing Assembly Removal," page 22).

> **CAUTION.** Before handling any Channel Master PC boards, always wear an earth-grounding static protection strap. The electronics in the Channel Master are very sensitive to static discharge. Static discharge can cause damage that will not be seen immediately and will result in early failure of electronic components.
>
> We assume that a qualified technician or equivalent will perform all of the following work.

e. With your earth-ground static protection strap on, push the side of the black plastic board clamp toward the edge of the board far enough so the Personality Module can be removed (see Figure 18). Pull out the Personality Module and replace it with the new module. Make sure the board clamp is securely snapped over the new Personality Module.

f. Replace the housing (see "Housing Assembly Replacement," page 26).

g. Test the Channel Master (see "Testing Your Channel Master," page 13).

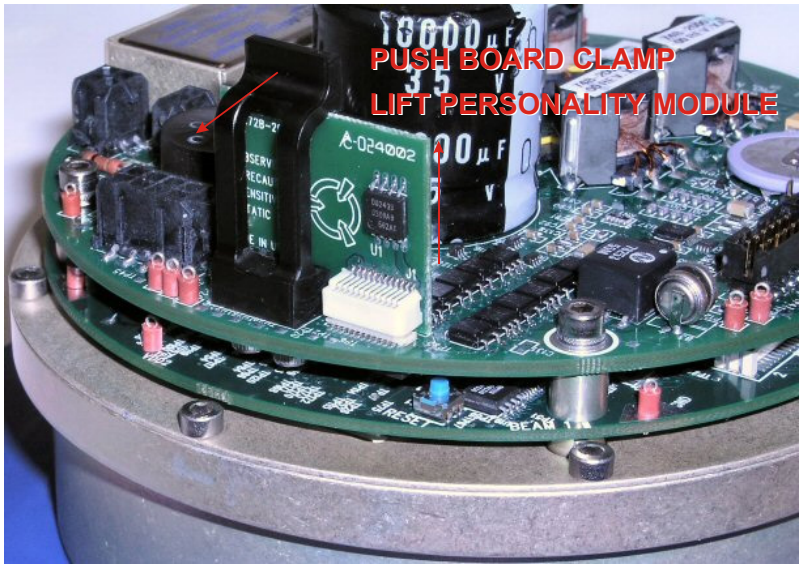


Figure 18. Personality Module

8.7 Desiccant Bags

Desiccant bags are used to dehumidify the housing interior. Desiccant is essential in deployments with plastic housings. The factory-supplied desiccant lasts a year at specified Channel Master deployment depths and temperatures. Remember that desiccant rapidly absorbs moisture from normal room air.

The average dry weight of a new desiccant bag is 7.2 grams ((5%). The weight increases to 8.4 to 9 grams for a "used" desiccant bag. Used desiccant bags may be dried at 250° for 14 hours. As a minimum, replace the desiccant bags whenever you are preparing to deploy or store the Channel Master for an extended time.

CAUTION. Do not open the desiccant bag. Contact with the silica gel can cause nose, throat, and skin irritation.

NOTE. Desiccant bags are shipped in an airtight aluminum bag to ensure maximum effectiveness. There is a moisture indicator inside the bag. If the moisture indicator is pink, do not use the desiccant bag until it has been dried. RDI recommends replacing the desiccant bag just before the deployment.

a. Remove the housing (see "Housing Assembly Removal," page 22).

b. Remove the new desiccant bags from the airtight aluminum bag.

c. Remove the old desiccant bags and install two new ones. Place the desiccant bags between the top circuit board and the housing.

d. Install the housing (see "Housing Assembly Replacement," page 26).

8.8 Sealing the Channel Master for a Deployment

Use Figure 16, page 24 and the following steps to seal the Channel Master for a deployment.

a. Check the Channel Master electronics; there should be no loose screws or missing hardware.

b. Add two fresh desiccant bags inside the Channel Master housing (see "Desiccant Bags," page 33).

c. Install the housing assembly (see "Channel Master Re-assembly," page 25).

d. The Channel Master is now ready for deployment unless you want to take steps to prevent biofouling (see "Prevention of Biofouling," page 34).

e. Test the Channel Master before the deployment.

8.9 Prevention of Biofouling

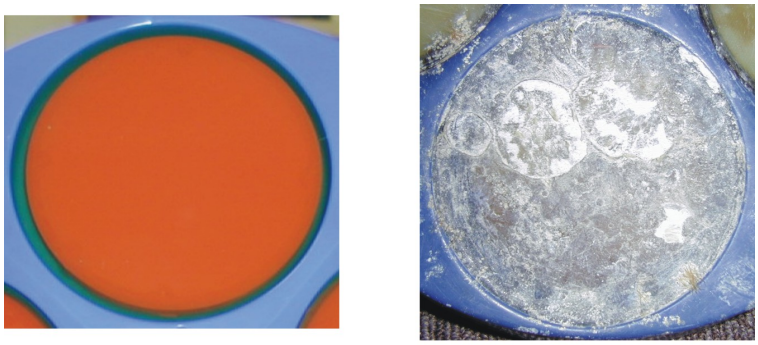
This section explains how to prevent the buildup of organic sea life (biofouling) on the transducer faces. Objects deployed within about 100 meters (≈328 feet) of the surface are subject to biofouling, especially in warm, shallow water. Soft-bodied organisms usually cause no problems, but barnacles can cut through the urethane transducer face causing failure to the transducer and leakage into the Channel Master (see Figure 19).

In shallow-water applications, the use of antifouling grease may be appropriate if you cannot clean the transducer faces often (weekly), and if the antifouling grease meets all of your local safety and environmental laws.

8.9.1 Controlling Biofouling

The best-known way to control biofouling is cleaning the Channel Master transducer faces often. However, in many cases this is not possible. The following options can help reduce biofouling.

- Coat the entire Channel Master except the pressure sensor and thermistor with the recommended antifouling paint. Make sure that the paint is applied in an even coat over the transducer faces.
- Apply a thin coat (≈4 mm; ≈0.16 in.) of either a 50:50 mix of chili powder and petroleum jelly or chili powder and silicone grease to the transducer faces. The chili powder should be the hottest that can be found. Water flowing across the transducers will wash this mix away over time. The silicone mixture tends to last longer.



BEFORE AFTER

Figure 19. Barnacle Damage

CAUTION. Barnacles can cut through the urethane transducer face causing failure to the transducer and leakage into the Channel Master.

If using antifouling grease, remove the grease immediately after recovering the Channel Master from its deployment. Remove the grease with soapy water. Be sure to wear protective gloves and a face shield.

CAUTION.

1. Do not arbitrarily use antifouling grease for every application. When barnacles are a threat to the transducer faces; using antifouling grease may be appropriate if you cannot clean the Channel Master regularly (weekly). If using antifouling grease, remove it immediately after recovering the Channel Master.

2. Antifouling grease is toxic. Read the product safety data sheet before using the grease. Wear gloves and a face shield when applying the grease. If the skin comes in contact with the grease, immediately wash the affected area with warm, soapy water.
3. All U.S. coastal states prohibit the use of tributyl-tins on boat hulls. The European Economic Commission has released a draft directive that would prohibit the use of many organo-tins after July 1989. We strongly recommend you obey your local laws.

8.9.2 Recommended Antifouling Paints

The plastic Channel Master housing simplifies anti-fouling paint application. You can use almost any EPA approved anti-fouling paint on the housing or the urethane transducer faces. You do have to be extra careful with the urethane faces. We recommend the TRILUX II paint from Interlux.

Manufacturer	Contact
Courtalds Finishes	Telephone: 908-686-1300
Interlux brand paints	Web Page: www.interlux.com

8.9.3 Applying Antifouling Paints

Follow the urethane faces application instructions for TRILUX II. One thin coat can last for several months.

NOTE. You cannot protect the pressure sensor from biofouling. The pressure sensor is located near the center of the transducer array, between the urethane-covered transducers. The sensor port is a small hole drilled through a screw (see "Pressure Sensor Maintenance," page 37). You must tape off the screw during anti-fouling paint application.

This means that the sensor port is not fully protected from bio fouling. The sensor port is surrounded by the antifouling paint, but bio fouling may build up on the screw, and eventually clog the sensor port. However, most organisms do not seem to find the small amount of unpainted surface attractive. If it is logistically possible to periodically inspect/clean the pressure sensor screw, it is highly recommended. This tradeoff situation must be analyzed for individual deployments. Unfortunately, the location of the deployment site usually dictates action in this regard.

Transducer Faces (urethane surfaces) and Plastic Housing

a. Lightly sand by hand the plastic housing and urethane face with 120-grit paper.

b. Mask off the Thermistor and Pressure Sensor copper screw.

c. Apply one or two coats of Trilux-2 at four mil/coat. If applying a second coat, wait at least 12 hours to allow the first coat to dry. One coat lasts one season (3-4 months); two coats might last one year.

8.10 Thermistor Maintenance

In order to respond quickly to changes in the water temperature, water must be able to flow over the sensor. Do not block the sensor or paint over it with antifouling paint. Remove any biofouling as soon as possible.

NOTE. The Thermistor is embedded in the transducer head. The sensor is under a titanium cover that is highly resistant to corrosion.

8.11 Pressure Sensor Maintenance

In order to read the water pressure, water must be able to flow through the copper screw on the pressure sensor. The tiny hole in the copper screw may at times be blocked. Use the following procedure and Figure 16, page 24 to clean the screw.

a. Place the Channel Master on its' housing end. Use a soft pad to protect the Channel Master.

b. Use a straight-slot screwdriver to remove the copper screw.

c. Gently clean out the hole in the copper screw with a needle. If the hole becomes enlarged or the screw is corroded, replace the screw. A replacement copper screw is included in the spare parts kit (part number 817-1067-00).

d. Install the copper screw. Tighten the screw "finger tight" (0.226 N-m, 2 lbf-in). Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the Channel Master to RDI for repair.

CAUTION.

The pressure sensor is filled with silicone oil. Never poke a needle or other object through the copper screw while the screw is installed over the pressure sensor. You will perforate the sensor, causing it to fail.

Do not remove the cover disc or attempt to clean the surface of the pressure sensor. The diaphragm is very thin and easy to damage.

Do not remove the pressure sensor. It is not field replaceable.

8.11.1 Pressure Sensor Cavity Oil Fill

The pressure sensor cavity needs to be filled with oil before deployment to deal with both trapped air and long-term reliability of the pressure sensor. The oil to be used is Dow Corning Q7-9120 Silicone fluid, 12,500 CST. This fluid is supplied with the Channel Master in the spare parts kit. The filling of the cavity can be completed any time before system installation however care should be taken to keep the Channel Master from high temperature during this time.

NOTE. The pressure sensor cavity is not filled with oil when shipped. This must be done before deploying the Channel Master.

Use the following procedure and Figure 16, page 24 and Figure 20, page 38 to fill the pressure sensor with oil.

a. Place the Channel Master on its side with the vertical beam facing down and the pressure sensor port facing up. Use a soft pad to protect the Channel Master.

b. Use a straight-slot screwdriver to remove the copper port screw on the pressure sensor. Do not remove the pressure sensor cover.

c. A plastic bottle with silicone oil (part number 75BK6004-00) is included in the spare parts kit. Place the tip of the bottle over the screw hole. Ensure the plastic bottle tip is not inserted into the screw hole. Slowly administer the oil into the cavity through the hole. Allow time for the air to escape as you fill. Once the oil level is up into the port screw hole, then stop filling.

d. Install the copper port screw slowly, allowing time for the oil to pass through the port screw orifice. Tighten the screw "finger tight" (0.226 N-m, 2 lbf-in). Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the Channel Master to RDI for repair.

NOTE. The Pressure sensor cavity should be checked and if needed refilled between deployments. Only remove the copper port screw for this inspection and re-fill.

Figure 20. Filling the Pressure Sensor Cavity with Oil

8.11.2 Zero the Pressure Sensor

Use the SZ-command to zero out the pressure sensor at the deployment site, prior to deploying the Channel Master in the water.

a. Connect and apply power to the system as described in "Setup the Channel Master," page 10.

b. Start *BBTalk* and wakeup the Channel Master (press the **END** key).

c. Type **SZ** and press the **Return** key.

d. Exit *BBTalk*.

8.12 Storage and Shipping Maintenance

This section lists the maintenance items to do before storing the Channel Master. These maintenance items include:

- Removing biofouling (see "Removal of Biofouling," page 39).
- Inspecting the transducer head (see "Transducer Head Inspection," page 40).
- Preparing the Channel Master for final storage or shipping (see "Final Storage or Shipping Preparation," page 40).

8.12.1 Removal of Biofouling

Before storing or shipping the Channel Master, remove all foreign matter and biofouling. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling. Rinse with fresh water to remove soap residue. Dry the transducer faces with low-pressure compressed air or soft lint-free towels.

CAUTION. The soft, thin urethane coating on the transducer faces is easily damaged. Do not use power scrubbers, abrasive cleansers, scouring pads, high-pressure marine cleaning systems, or brushes stiffer than hand cleaning brushes on the transducer faces.

If there is heavy fouling or marine growth, the transducer faces may need a thorough cleaning to restore acoustic performance. Barnacles do not usually affect Channel Master operation. We do however recommend removal of the barnacles to prevent water leakage through the transducer face. Lime dissolving liquids such as Lime-Away® break down the shell-like parts. Scrubbing with a medium stiffness brush usually removes the soft-bodied parts. Do NOT use a brush stiffer than a hand cleaning brush. Scrubbing, alternated with soaking in Lime-Away®, effectively removes large barnacles. After using Lime-Away®, rinse the Channel Master with fresh water to remove all residues. If barnacles have entered more than 1.0 to 1.5 mm (0.06 in.) into the transducer face urethane, you should send the Channel

Master to RDI for repair (see Figure 19, page 34). If you do not think you can remove barnacles without damaging the transducer faces, contact RDI.

8.12.2 Transducer Head Inspection

The urethane coating on the transducer faces is important to Channel Master watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive depth pressures can damage the transducer ceramics or urethane coating. Inspect the transducer faces for dents, chipping, peeling, urethane shrinkage, hairline cracks, and damage that may affect watertight integrity or transducer operation. Repair of the transducer faces should only be done by RDI.

CAUTION. Never set the transducer on a rough surface; always use foam padding to protect the transducers.

NOTE. The dummy plug should be installed any time the I/O cable is removed. Use the dummy plug when the Channel Master is in storage or is being handled.

8.12.3 Final Storage or Shipping Preparation

This section explains how to store or ship the Channel Master.

CAUTION. If you are shipping a Channel Master to RDI for repair or upgrade, remove all customer-applied coatings or provide certification that the coating is nontoxic. This certification must include the name of a contact person who is knowledgeable about the coating, the name, and manufacturer of the coating, and the appropriate telephone numbers. If you return the equipment without meeting these conditions, we have instructed our employees not to handle the equipment and to leave it in the original shipping container pending certification. If you cannot provide certification, we will return the equipment to you or to a customer-specified cleaning facility. All costs associated with customer-applied coatings will be at the customer's expense.

When shipping the Channel Master through a Customs facility, be sure to place the unit/s so identifying labels are not covered and can be seen easily by the Customs Inspector. Failure to do so could delay transit time.

NOTE. RDI strongly recommends using the original shipping crate whenever transporting the Channel Master.

If you need to ship or store the Channel Master, use the original shipping crate whenever possible. If the original packaging material is unavailable or unserviceable, additional material is available through RDI.

For repackaging with commercially available materials, use the following procedure:

a. Use a strong shipping container made out of wood or plastic.

b. Install a layer of shock-absorbing static-shielding material, 70-mm to 100-mm thick, around all sides of the instrument to firmly cushion and prevent movement inside the container.

c. Seal the shipping container securely.

d. Mark the container FRAGILE to ensure careful handing.

e. In any correspondence, refer to the Channel Master by model and serial number.

8.13 Returning Channel Masters to RDI for Service

When shipping the Channel Master to RDI from either inside or outside the United States, the following instructions will help ensure the Channel Master arrives with the minimum possible delay. Any deviation from these instructions increases the potential for delay.

8.13.1 Domestic Shipments

Step 1 - Get a Return Authorization

The best way to make sure RDI is aware of your intentions to ship equipment is to obtain a Return Material Authorization (RMA) before sending the shipment. Return Material Authorizations are issued by Sales Administration or Customer Service and are used to notify us of your needs in advance of arrival so we can provide a faster turnaround. When requesting a Return Material Authorization, please give us the following information.

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What problem(s) need correction
- When you need the instrument returned

When the Return Material Authorization is issued, we will tell you the RMA number. Please include this number on all packages and correspondence.

Step 2 - Ship via air freight, prepaid

Urgent Shipments should be shipped direct to RDI via any of several overnight or priority air services. Do not send urgent airfreight as part of a consolidated shipment. If you ship consolidated, you will save money, but may lose up to three days in transit time.

Non-urgent shipments may be shipped as part of a consolidated cargo shipment to save money. In addition, some truck lines may offer equivalent delivery service at a lower cost, depending on the distance to San Diego.

Mark the Package(s)

To: RD Instruments, Inc. (RMA Number)
9855 Businesspark Avenue
San Diego, CA 92131-1101

Step 3 - Urgent shipments

Send the following information by fax or telephone to RDI.

Attention: Sales Administration
Fax: (858) 695-1459
Phone: (858) 693-1178

- Detailed descriptions of what you are shipping (number of packages, sizes, weights, and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take

8.13.2 International Shipments

Step 1 - Get a Return Authorization

The best way to make sure RDI is aware of your intentions to ship equipment is to obtain a Return Material Authorization (RMA) before sending the shipment. Return Material Authorizations are issued by Sales Administration or Customer Service and are used to notify us of your needs in advance of arrival so we can provide a faster turnaround. When requesting a Return Authorization, please give us the following information.

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What problem(s) need correction
- When you need the instrument returned

When the Return Material Authorization is issued, we will tell you the RMA number. Please include this number on all packages and correspondence.

Step 2 - Ship Via Air Freight, Prepaid

Urgent Shipments should be shipped direct. Do not send urgent airfreight as part of a consolidated shipment. If you ship consolidated, you will save money, but may lose up to five days in transit time.

Non-urgent shipments may be shipped as part of a consolidated cargo shipment to save money.

Mark the package(s) as follows:

To: RD Instruments, Inc. (RMA Number)
5 Avenue Hector Pintus
06610 La Gaude, France

Step 3 - Include Proper Customs Documentation

The Customs statement should be completed very carefully. It should accurately and truthfully contain the following information.

- Contents of the shipment
- Value
- Purpose of shipment (example: "American made goods returned for repair")
- Any discrepancy or inaccuracy in the Customs statement could cause the shipment to be delayed in Customs.

Step 4 - Send the Following Information by Fax or Telephone to RDI

Attention: Sales Administration
Phone: +33(0) 492-110-930
Fax: +33(0) 492-110-931

- Detailed descriptions of what you are shipping (number of packages, sizes, weights, and contents).
- The name of the freight carrier
- Master Air bill number
- Carrier route and flight numbers for all flights the package will take

9 Channel Master Installation

This section is a guide for installing the Channel Master. Use this section to plan your installation layout. We recommend you distribute this information to your organization's decision-makers and installation engineers.

9.1 Mounting Plate Assembly

Assemble the mounting plate by connecting the four standoffs to the base plate (see Figure 21). Mount the standoffs with the flat end toward the base plate. Use the provided M6x1.0x16 flat head screws.

Figure 21. Mounting Plate Assembly

9.2 Orientation and Tilt

The Channel Master must be mounted with its transducer orientation in the horizontal direction. That is, the two larger transducers, which are for water velocity measurement, must be looking horizontally (also called side-looking). The third transducer, which is for water depth measurement, must be looking up towards the water surface.

We recommend the Channel Master be mounted with its Y-axis of the instrument coordinate perpendicular to the direction of the channel mean flow. The Channel Master X-axis (direction from Beam 2 to Beam 1) should be parallel to the channel main flow direction (Figure 22, page 45).

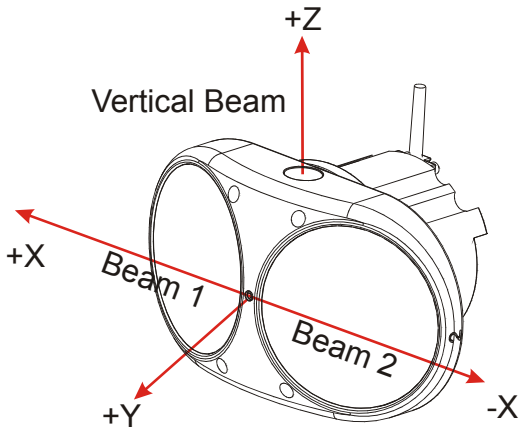


Figure 22. Channel Master Instrument Coordinates

It is important to mount the Channel Master with the two horizontal acoustic beams in the same horizontal plane (zero roll). A small tilt of the Channel Master may result in an interference of the acoustic beams with either the channel bottom or water surface (see Figure 23). The Channel Master is equipped with a tilt sensor that can be used to guide in mounting. During installation, the user can monitor the pitch and roll readings through the real-time program *WinHADCP* and adjust the mounting fixture as needed.

NOTE. Depending on channel cross-section geometry, the user may want the Channel Master mounted with a small upward lean (positive pitch), or downward lean (negative pitch) to avoid any interference of the acoustic beams with either the river bottom or water surface. The lean must be determined by field tests. However, in any case, the Channel Master must be mounted with zero roll.

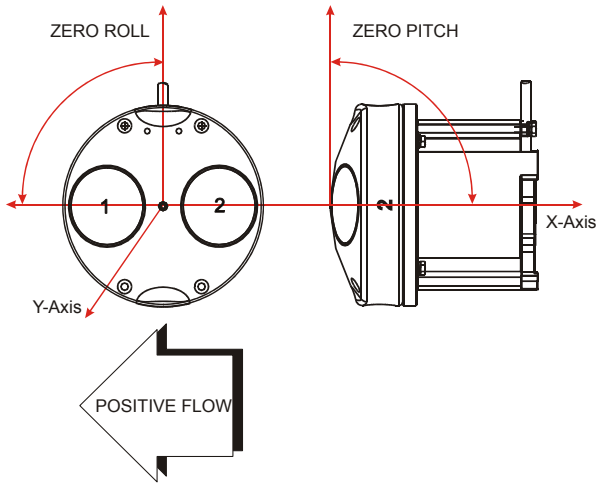


Figure 23. Channel Master Mounting Pitch and Roll

9.3 Installing the Channel Master on Site

The Channel Master must be mounted on a rigid structure in the channel, such as a solid wall, pier, or pile. The mounting structure must be firm, stable, without settlement or displacement over time.

> **NOTE.** In order to gain the maximum profiling range at a site, we recommend the Channel Master be mounted near the middle of the water depth at the mounting structure location. For a site with a significant seasonal change of water level, the Channel Master may need to be mounted at different elevations according to the seasonal water level change.

The recommended mounting procedure is described below. A diver may be needed for the installation work.

a. Assemble the mounting plate (see "Mounting Plate Assembly," page 44).

b. Install the mounting fixture on the structure with four screws embedded in or attached to the mounting base. See the "Mounting Plate Drawing," page 137 for the size and arrangement of the four screw holes.

> **NOTE.** The four screws/bolts required to mount the base plate to your structure are not provided by RD Instruments.

> **NOTE.** For best results, select a mounting location so that the Channel Master X-axis (direction from Beam 2 to Beam 1) is parallel to the channel main flow direction (Figure 22, page 45).

c. Connect the I/O cable to the Channel Master. Attach the cable strain relief.

d. Slide the Channel Master into the mounting fixture and secure the Channel Master by using the provided four M6 socket head screws, lock washers, and flat washers through the holes on the Channel Master transducer head (see Figure 24, page 47).

e. Adjust the mounting fixture to make the Channel Master zero pitch and roll or a desired lean pitch and zero roll.

f. Run the real-time program *WinHADCP* with the desired parameter settings. Examine the acoustic backscattering intensity profile and look for any obstacle to the acoustic beams, surface or bottom interference, or side lobe effect. Adjust the Channel Master lean if needed. Also examine the velocity profile for reasonability.

g. Secure the cable by attaching it to the structure. Use a plastic tube to protect the cable for permanent installations.

NOTE. It should be emphasized that the acoustic backscattering intensity profile is the most important parameter for Channel Master data quality control and assurance. We recommend the user examine the intensity profile during the installation to make sure the profile does not show any thing abnormal. The velocity data will be questionable if the intensity profile is abnormal. The intensity profile should also be monitored during the Channel Master operation.

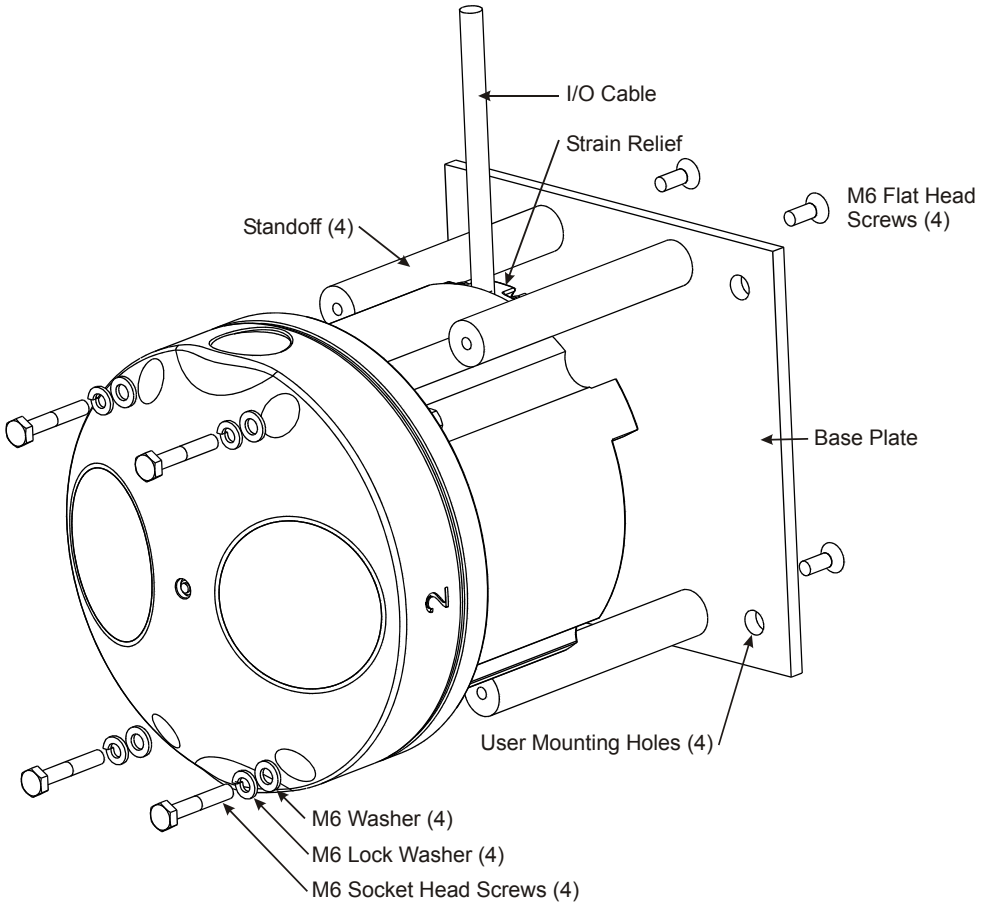


Figure 24. Channel Master Mounting Plate Overview

10 Channel Master Commands

This section defines the commands used by the Channel Masters. These commands let you set up and control the Channel Master without using an external software program such as our *WinHADCP* program. However, we recommend you use our software to control the Channel Master because entering commands directly from a terminal can be difficult. Most Channel Master settings use factory-set values. If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has before using it*. Call RDI if you do not understand the function of any command.

Using *WinHADCP* for real-time deployments to develop the command file will ensure that the Channel Master is set up correctly. The commands directly affect the range of the Channel Master and the standard deviation (accuracy) of the data.

10.1 Data Communication and Command Format

You can enter commands with an IBM-compatible computer running RDI's *BBTalk*. The Channel Master communicates with the computer through an RS-422 serial interface. We initially set the Channel Master at the factory to communicate at 9600 baud, no parity, and one stop bit.

Immediately after you apply power to the Channel Master, it enters the STANDBY mode. Send a BREAK signal using *BBTalk* by pressing the **End** key. When the Channel Master receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The Channel Master is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
Horizontal ADCP
RD Instruments (c) 2005
All rights reserved.
Product Version: CM02.01
>
```

10.1.1 Command Input Processing

Input commands set Channel Master operating parameters, start data collection, run built-in tests (BIT), and asks for output data. All commands are ASCII character(s) and must end with a carriage return (CR). For example,

```
>WP0001<CR> [Your input]
```

If the entered command is valid, the Channel Master executes the command. If the command is one that does not provide output data, the Channel Master sends a carriage return line feed <CR> <LF> and displays a new ">" prompt. Continuing the example,

```
>WP00001<CR>      [Your original input]
>                 [Channel Master response to a valid, no-output command]
```

If you enter a valid command that produces output data, the Channel Master executes the command, displays the output data, and then redisplays the ">" prompt. Some examples of commands that produce output data are **?** (help menus), **CS** (start pinging), **PS** (system configuration data), and **PA** (run built-in tests).

If the command is not valid, the Channel Master responds with an error message similar to the following.

```
>WPA<CR>                                        [Your input]
>WPA  ERR 002:  NUMBER EXPECTED<CR><LF>         [Channel Master response]
>
```

After correctly entering all the commands for your application, you would send the CS-command to begin the data collection cycle.

10.1.2 Data Output Processing

After the Channel Master completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected and averaged during the ensemble interval (see "TE – Time Per Ensemble," page 83). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, percent good, status, surface track fields, and firmware version data.

Channel Master output data can be in either hexadecimal-ASCII (Hex-ASCII) or binary format (set by "CF – Flow Control," page 54). The Hex-ASCII mode is useful when you use a terminal to communicate with, and view data from the Channel Master. The binary mode is useful for high-speed communication with a computer program. You would not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.

NOTE. *WinHADCP* supports PD0, PD14, and PD19 Output Data Formats (see "PD – Data Stream Select," page 77).

When data collection begins, the Channel Master uses the settings last entered (user settings) or the factory-default settings. The same settings are used for the entire deployment.

The Channel Master automatically stores the last set of commands used in RAM. The Channel Master will continue to be configured from RAM until it receives a CR-command or until the RAM loses its backup power. If the Channel Master receives a CR0 it will load into RAM the command set you last stored in non-volatile memory (semi-permanent user settings) through the CK-command. If the Channel Master receives a CR1, it will load into RAM the factory default command set stored in ROM (permanent or factory settings).

10.2 Command Descriptions

Each listing includes the command's purpose, format, default setting (if applicable) range, recommended setting, and description. When appropriate, we include amplifying notes and examples. If a numeric value follows the command, the Channel Master uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, and dm).

10.2.1 Miscellaneous Commands

? – Help Menus

Purpose Lists the major help groups.

Format *x*? (see description)

Description Entering ? by itself displays all command groups. To display help for one command group, enter *x*?, where *x* is the command group you wish to view. When the Channel Master displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command followed by a question mark. For example, to view the CB-command setting enter CB?.

Examples See below.

```
>?
Available Commands:

C ---------------------- Control Commands
E ---------------------- Environment Commands
I ---------------------- Index Commands
M ---------------------- Loop Recorder Commands
P ---------------------- Performance Test Commands
S ---------------------- Sensor Commands
T ---------------------- Time Commands
V ---------------------- Vertical Beam Commands
Y ---------------------- Display Banner
W ---------------------- Water Profiling Commands
? ---------------------- Display Main Menu
>C?
Available Commands:

CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11110 ----------------- Set Ctrl Flags {e;p;b;s;*}
CJ 0,0,0 ----------------- SDI-12 Configuration {En/Dis,Addr,E/M }
CK ----------------------- Save Command Parameters to Flash
CL 1 --------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR ----------------------- Restore Cmd defaults [0=user,1=factory]
CS ----------------------- Start Pinging
CT 0 --------------------- Turnkey (0 = OFF, 1 = ON)
CZ ----------------------- Put the ADCP to sleep.
C? ----------------------- Display C-Command Menu
>
>CB?
CB 811 ------------------ Serial Port Control {baud;parity;stop}
>
```

Break

Purpose	Interrupts the Channel Master without erasing present settings.
Format	<BREAK>
Description	A BREAK signal interrupts Channel Master processing. It is leading-edge triggered and must last at least 300 ms. A BREAK initializes the system, sends a wake-up (copyright) message, and places the Channel Master in the DATA I/O mode. The BREAK command does not erase any settings or data. Using *BBTalk*, pressing the **End** key sends a BREAK. Software Breaks can be used with *BBTalk*. On the **Tools** menu, click **Options** and select the **Use Software Break** box. The Channel Master will use the "= = =" or "+++" strings instead of a break.

Y – Display Banner

Purpose	Displays the banner.
Format	Y
Description	Use the Y command to display the Channel Master banner.

```
>Y
Horizontal ADCP
RD Instruments (c) 2006
All rights reserved.
Product Version: CM02.04
```

10.3 Control System Commands

The Channel Master uses the following commands to control certain system parameters.

```
>C?
Available Commands:

CB 811 ------------------ Serial Port Control {baud;parity;stop}
CF 11110 ----------------- Set Ctrl Flags {e;p;b;s;*}
CJ 0,0,0 ----------------- SDI-12 Configuration {En/Dis,Addr,E/M }
CK ----------------------- Save Command Parameters to Flash
CL 1 --------------------- Sleep Enable ( 1=Enabled, 0=Disabled )
CR ----------------------- Restore Cmd defaults [0=user,1=factory]
CS ----------------------- Start Pinging
CT 0 --------------------- Turnkey (0 = OFF, 1 = ON)
CZ ----------------------- Put the ADCP to sleep.
C? ----------------------- Display C-Command Menu
>
```

10.3.1 Control System Command Descriptions

This section lists the Control System commands.

CB – Serial Port Control

Purpose — Sets the RS-232/422 serial port communications parameters (Baud Rate/Parity/Stop Bits).

Format — CB*nnn*

Range — *nnn* = baud rate, parity, stop bits (see description)

Default — CB411

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description — The Channel Master and your external device (dumb terminal, computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the Channel Master responds with a ">" prompt. You may now change the external device's communication parameters to match the Channel Master parameters before sending another command.

Table 8: Serial Port Control

Baud Rate	Parity	Stop Bits
0 = NA	0 = None	0 = 1
1 = 1200	1 = None (Default)	1 = 1 Bit (Default)
2 = 2400	2 = Even	2 = 2 Bits
3 = 4800	3 = Odd	
4 = 9600 (Default)	4 = Low (Space)	
5 = 19200	5 = High (Mark)	
6 = 38400		
7 = 57600		
8 = 115200		

Setting The Baud Rate In The Channel Master. The Channel Master can be set to communicate at baud rates from 300 to 115200. The factory default baud rate is always 9600 baud. The baud rate is controlled via the CB-command. The following procedure explains how to set the baud rate and save it in the Channel Master. This procedure assumes that you will be using the program *BBTalk* that is supplied by RD Instruments.

a. Connect the Channel Master to the computer and apply power (see "Setup the Channel Master," page 10).

b. Start the *BBTalk* program and establish communications with the Channel Master. Wakeup the Channel Master by sending a break signal with the **End** key.

c. Send the command **CR1** to place the Channel Master in the factory default setup.

d. Send the CB-command that selects the baud rate you wish. The following are the typical CB-command settings for different baud rates with no parity and 1 stop bit:

Table 9: Baud Rate

BAUD RATE	CB-command
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

e. *BBTalk* will change the communication settings to match your CB command settings.

f. Send the command **CK** to save the new baud rate setting.

g. Click **File**, **Close** to exit the terminal window.

The Channel Master is now set for the new baud rate. The baud rate will stay at this setting until you change it back with the CB-command.

NOTE. If you send a BREAK before changing the external device's communication parameters, the Channel Master returns to the communication parameters stored in non-volatile memory (user settings).

CF – Flow Control

Purpose Sets various Channel Master data flow-control parameters.

Format CF*nnnnn*

Range Firmware switches (see description)

Default CF11110

Recommended Setting. The default setting for this command is recommended for most applications.

Description The CF-command defines whether the Channel Master: generates data ensembles automatically or manually; generates pings immediately or manually; sends serial output data in binary or Hex-ASCII format; sends or does not send output data to the serial interface; sends or does not send data to the loop recorder.

Table 10: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the ">" prompt and waits for a new command.
CFx1xxx	Automatic Ping Cycling – Pings immediately when ready.
CFx0xxx	Manual Ping Cycling – Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the Channel Master is not echoed. This feature lets you manually control ping timing within the ensemble.
CFxx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CFxx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
CFxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/485/422 serial interface.
CFxxx0x	Disable Serial Output – No ensemble data are sent out the RS-232/485/422 interface.
CFxxxx1	Enable Loop Recorder – Records data ensembles on the Loop Recorder.
CFxxxx0	Disable Loop Recorder – No data ensembles are recorded on the Loop Recorder.
Example	CF01010 selects manual ensemble cycling, automatic ping cycling, Hex-ASCII data output, enables serial output, and disables data recording.

CJ – SDI-12 Configuration

Purpose This command is used to enable SDI-12 communications.

Format CJ *x,y,z*

x – Enable/Disable (0 = Disable, 1 = Enable)

y – Address (The address can be any alphanumeric character)

z – English/Metric Units for output (0 = Metric, 1 = English)

Default CJ 0,0,0

Recommended Setting. Use as needed.

Description This command is used to enable SDI-12 communications for data logging purposes only. It allows for configuration of the SDI-12 Address and the units of the data returned from the unit (English or Metric). The address, as specified by the SDI-12 Specification v1.3, can be any alphanumeric character. The data output can be in English or Metric Units. English units are °F, ft, and ft/s. Metric Units are °C, m, and m/s.

Example

```
>CJ?
CJ 0,0,0 -------------- SDI-12 Configuration {En/Dis,Addr,E/M }
>CJ1,0,1
>CJ?
CJ 1,0,1 -------------- SDI-12 Configuration {En/Dis,Addr,E/M }
```

NOTES. The IU command controls the units for discharge data when reported through the serial port (for example, if PD19 is enabled) (see "IU - Output Units," page 69).

The CJ command sets the units for the same data when reported by SDI-12 (M9 command).
IU1,1,1,1,1 sets the same units as CJ1,0,0
IU2,2,2,2,2 sets the same units as CJ1,0,1

CK – Keep Parameters

Purpose Stores present parameters to non-volatile memory.

Format CK

Recommended Setting. Use as needed.

Description CK saves the present user command parameters to non-volatile memory on the CPU board. The Channel Master maintains data stored in the non-volatile memory (user settings) even if power is lost. It does not need a battery. You can recall parameters stored in non-volatile memory with the CR0-command.

CL - Battery Saver Mode

Purpose — Determines whether the Channel Master will attempt to conserve power.

Format — CLn

Range — n = 0 to 1 (0 = do not conserve power, 1 = conserve power)

Default — CL1

Recommended Setting. The default setting for this command is recommended for most applications.

Description — CL0 means the ADCP will not make any attempt to conserve power. Setting the CL command to CL1 means the ADCP will attempt to conserve power by going to sleep at every opportunity.

NOTE. In order for software breaks to work, the CL-command must be set to CL0.

CR – Retrieve Parameters

Purpose — Resets the Channel Master command set to factory or user settings.

Format — CR*n*

Range — *n* = 0 (User), 1 (Factory)

Recommended Setting. Use as needed.

Description — The Channel Master automatically stores the last set of commands used in RAM. The Channel Master will continue to be configured from RAM unless it receives a CR-command or until the RAM loses its power.

Table 11: Retrieve Parameters

Format	Description
CR0	Loads into RAM the command set last stored in non-volatile memory (user settings) using the CK-Command.
CR1	Loads into RAM the factory default command set stored in ROM (factory settings).

NOTE. CR keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the Channel Master maintains communications with the terminal/computer.

CS – Start Pinging (Go)

Purpose — Starts the data collection cycle (same as the **Tab** key in *BBTalk*).

Format — CS

Recommended Setting. Use as needed. Use *WinHADCP* to create the command file. The CS command will be added to the end of the command file or sent by the software.

Description — Use CS (or the **Tab** key in *BBTalk*) to tell the Channel Master to start pinging its transducers and collecting data as programmed by the other commands.

NOTE. After a CS-command is sent to the Channel Master, no changes to the commands can occur until a <BREAK> is sent (auto ensemble cycling or at the > prompt if using manual ensemble cycling). See the CF – Flow Control command, page 54.

If you are using SDI-12 communications, the <BREAK> must be sent to the RS-232 port.

CT - Turnkey Operation

Purpose — Allows the Channel Master to initialize to predefined parameters and start pinging immediately after power is applied.

Format — CT*n*

Range — *n* = 0 to 1 (0 = Off, 1 = Turnkey)

Default — CT0

Description — Setting the CT command to CT1 lets the Channel Master automatically initialize to a predefined command set during any power up. To place the Channel Master in turnkey mode, you must first set all other commands to the desired configuration. You must then send the CT1 and CK commands to save this configuration. When power is cycled, the Channel Master will start up with the desired configuration and begin the data collection process. You can interrupt (not remove) this mode by sending a <BREAK>. This will place the Channel Master in the command mode, ready to accept inputs. Cycling the power, however, will again start the data collection process.

To turn off the turnkey mode, first send a <BREAK> to the Channel Master. Now send the CT0 and CK commands to save this configuration. When power is cycled, the Channel Master will NOT begin the data collection process.

CZ – Power Down Channel Master

Purpose Tells the Channel Master to power down.

Format CZ

Recommended Setting. Use as needed.

Description Sending the CZ-command powers down the Channel Master. Channel Master processing is interrupted and the Channel Master goes in the STANDBY mode (RAM is maintained).

NOTES.

1. When powered down using the CZ-command, the Channel Master still draws up to 30μa, but wakes up periodically (every 8 to 12 hours) for a few seconds to maintain RAM.

2. This command should be used whenever batteries have been installed and you do not send commands to start a deployment. If you do not use the CZ-command, the Channel Master will draw up to 50 milli-amps of current. *A new battery will be discharged in a few days*.

10.4 Environmental Commands

The Channel Master uses the following commands to control the environmental and positional information that affects internal data processing.

```
>E?
Available Commands:

EC 1500 ----------------- Speed Of Sound (m/s)
ED 00000 ---------------- Xdcr Depth (deci-meters)
ES 00 ------------------- Salinity (ppt)
ET 2100 ----------------- Water Temperature (.01 deg C)
EX 01010 ---------------- Coordinate Transformations
EZ 1101101 -------------- Sensor Source {c;d;h;p;r;s;t}
E? ---------------------- Display E-Command Menu
```

10.4.1 Environmental Command Descriptions

This section lists the Environmental commands.

EC – Speed of Sound

Purpose	Sets the speed of sound value used for Channel Master data processing.
Format	EC*nnnn*
Range	*nnnn* = 1400 to 1600 meters per second
Default	EC1500

Recommended Setting. The default setting for this command is recommended for most applications.

Description	EC sets the sound speed value used by the Channel Master to scale velocity data, cell size, and range to the bottom. The Channel Master assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

NOTE. If the EZ Speed of Sound field = 1, the Channel Master overrides the manually-set EC value and calculates speed of sound using the values determined by transducer depth (ED), salinity (ES), and transducer temperature (ET). EZ also selects the source for ED, ES, and ET.

ED – Depth of Transducer

Purpose	Sets the Channel Master transducer depth.
Format	ED*nnnnn*
Range	*nnnnn* = 0 to 65535 decimeters (meters x 10)
Default	ED00000

Recommended Setting. Use the EZ-command (set by *WinHADCP*).

Description ED sets the Channel Master transducer depth. This measurement is taken from the water surface to the transducer faces. The Channel Master uses ED in its speed of sound calculations. The Channel Master assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

NOTE. If the EZ *Transducer Depth* field = 1, the Channel Master overrides the manually set ED value and uses depth from the internal pressure sensor. If a pressure sensor is not available, the Channel Master uses the manual ED setting.

ES – Salinity

Purpose Sets the water's salinity value.

Format ES*nn*

Range *nn* = 0 to 50

Default ES00

Recommended Setting. Set using *WinHADCP*. The default setting for this command is recommended for most applications.

Description ES sets the water's salinity value. The Channel Master uses ES in its speed of sound calculations. The Channel Master assumes the speed of sound reading is taken at the transducer head.

ET – Temperature

Purpose Sets the water's temperature value.

Format ET±*nnnn*

Range ±*nnnn* = -5.00 C to +40.00 C

Default ET2100

Recommended Setting. Use the EZ-command.

Description ET sets the temperature value of the water. The Channel Master uses ET in its speed of sound calculations (see the primer). The Channel Master assumes the speed of sound reading is taken at the transducer head.

Example Convert temperatures of +14 C and -3.5 C to ET-command values.

```
ET = 14.00 × 100 = 1400 = ET1400 (+ is understood)
ET = -3.50 × 100 = -350 = ET-0350
```

NOTE. If the EZ Temperature field = one, the Channel Master overrides the manually set ET value and uses temperature from the transducer's temperature sensor. If the sensor is not available, the Channel Master uses the manual ET setting.

EX – Coordinate Transformation

Purpose	Sets the coordinate transformation processing flags.
Format	EX*nnnnn*
Range	Firmware switches (see description)
Default	EX01010

Recommended Setting. The default setting for this command is recommended for most applications.

Description EX sets firmware switches that control the coordinate transformation processing for velocity and percent-good data.

Table 12: Coordinate Transformation Processing Flags

Setting	Description
EX 00xxx	Output beam radial velocities
EX 01xxx	Transform velocities to instrument coordinates (X, Y where X is parallel to the transducer face; Y is normal to the transducer face)
EX xx0xx	Reserved, must be zero
EX xxx1x	Reserved, must be one
EX xxxx0	Reserved, must be zero

NOTE. Bit 2 is reserved, and must be set to one for the Channel Master systems to get any velocity solution.

The Channel Master will not transform the data with only one good beam.

EZ – Sensor Source

Purpose Selects the source of environmental sensor data.

Format EZ*cdhprst*

Default EZ1101101

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Range Firmware switches (see description)

Description Setting the EZ-command firmware switches tells the Channel Master to use data from a manual setting or from an associated sensor. When a switch value is non-zero, the Channel Master overrides the manual E_ command setting and uses data from the appropriate sensor. If no sensor is available, the Channel Master defaults to the manual E_ command setting. The following table shows how to interpret the sensor source switch settings.

Table 13: Sensor Source Switch Settings

	Field	Value = 0	Value = 1	Value = 2	Value = 3
c	Speed Of Sound	Manual EC	Calculate using ED, ES, and ET	N/A	N/A
d	Depth	Manual ED	Depth Sensor	N/A	N/A
h	Heading	N/A	N/A	N/A	N/A
p	Pitch (Tilt 1)	Force 0	Internal Transducer Sensor	N/A	N/A
r	Roll (Tilt 2)	Force 0	Internal Transducer Sensor	N/A	N/A
s	Salinity	Manual ES	N/A	N/A	N/A
t	Temperature	Manual ET	Internal Transducer Sensor	N/A	N/A

Example EZ1101101 means calculate speed of sound from readings, use pressure sensor, internal tilt sensors, and the transducer temperature sensor.

> **NOTE.** If the bits for Pitch (Tilt 1) or Roll (Tilt 2) sensor are set to zero, then a pitch or roll value of zero will be output.

10.5 Index Velocity and Discharge Commands

The Index Velocity and Discharge Commands allow the user to input data and scale outputs to obtain average velocity, stage, cross-sectional area, discharge, and integrated volume directly from the Channel Master either via serial RS-232/RS-422 or via SDI-12.

Rather than describe the commands in alphabetic order, it will be clearer to describe them by functional grouping and logical order of their application. The commands can be grouped into three distinct groups:

- See "Channel Description Commands," page 64 (IA, IC, ID, IE, IP, and IW)
- See "Computation Commands," page 67 (IB, IS, and IV)
- See "Output Commands," page 69 (IF, IO, IT, IU, and IZ)

Command Summary

If you send 'I?' to the Channel Master you will receive back:

```
>I?
Available Commands:

IA  1.000, 1.000, 1.000 - Area Rating Constants (-10000000 to 10000000)
IB 1 -------------------- Bank 0=left,1=right
IC 1 -------------------- Channel 0=cir,1=tra,2=rec,3=arb,4=rated
ID   1.000 -------------- Diameter (0.5 to 100m)
IE    0.000,   0.000 ---- Xdcr Elev.(0 to 5000m), Bot Elev. (-100 to 5000m)
IF  10 ------------------ Flag Counter (1 to 100)
IO 0 -------------------- Q Calc. 0=off, 1=on
IP ---------------------- XY pairs IP0=help
IS ---------------------- Select Velocity Bins IS0=help
IT   0,  0 -------------- Output Exponent Dis,Vol (0 to 6)
IU   1,  1,  1,  1,  1 -- Output Units Vel,Dis,Vol,Area,Stage 0=help
IV  1.000, 1.000,  1.000  V. Equation Const. (-5to5,-5to5,-10to10)
IW   1.000,  1.000 ------ BotWidth (0 to 500 m), SideSlope (run/rise)
IZ  +0, -329.95 ------ -------- ZeRo Volume Accumulator
I? ---------------------- Display I-Command Menu
```

10.5.1 Channel Description Commands

In order to compute cross-sectional area from stage, the shape of the channel needs to be described. The IA, IC, ID, IE, IP, and IW commands are used for this purpose.

IA - Area Rating Constants

Purpose	Used to compute area of a rated channel using a rating equation.
Format	IA a.aaa, b.bbb, c.ccc
Range	-10000000 to 10000000
Default	IA 1.000, 1.000, 1.000

Recommended Setting. Set using *WinHADCP*.

Description These three parameters are used to compute area using a rating equation for cross-sectional area of a rated channel where

Area = a.aaa * H^2 + b.bbb * H + c.ccc

H is the stage where

H = range to surface + mounting elevation

Range to surface is the range measured by the vertical acoustic beam and mounting elevation is from the first parameter of the IE command.

IC – Channel Type

Purpose	Sets the shape of the channel.
Format	ICn
Range	n = 0 (circular), 1 (trapezoidal), 2 (rectangular), 3 (arbitrary), 4 (rated)
Default	IC3

Recommended Setting. Set using *WinHADCP*.

Description The IC command is used to select the overall shape of the channel.

ID - Diameter

Purpose	Sets the diameter of a circular channel.
Format	ID n.nnn
Range	0.5 to 100 meters
Default	ID 1.000

Recommended Setting. Set using *WinHADCP*.

Description The ID commands sets the diameter of a circular channel in meters. Diameters from 0.5 to 100 meters are allowed.

IE - Transducer Elevation

Purpose	Sets the mounting elevation of the Channel Master.
Format	IE m.mmm, n.nnn
Range	m = 0 to 5000 meters, n = -100 to 5000 meters
Default	IE 1.000, 0.000

Recommended Setting. Set using *WinHADCP*.

Description the first value is the mounting elevation of the Channel Master. The second value is the elevation of the bottom of the channel (for circular, trapezoidal and rectangular channels). Both values are in meters. The range of allowed values for the first parameter is 0 to 5000 meters and the allowed range for the second parameter is -100 to 5000 meters.

IP - XY pairs

Purpose	Used to provide the geometric details of the channel shape for an arbitrary channel.
Format	IP n, x.xxx, y.yyy
Range	n = 1 to 99, x = 1 to 9998, y = 1 to 9998 (IP0 = help)
Default	N/A

Recommended Setting. Set using *WinHADCP*.

Description The initial position command is a list of up to 99 x, y pairs describing the cross-section of the bottom of the channel. The first value 'n' is the number of the coordinate pair in order from one side to the other. The next two values are the horizontal distance across the channel and then the elevation of the bottom at that distance. To end the list enter 9999, 9999 for x and y. Entries below this are disregarded. Each n, x, y triplet

must be entered on a separate line. For example, a channel with four x, y pairs would be entered as:

```
IP 1, 10.5, 20.2
IP 2, 15.3, 15.9
IP 3, 20.22, 17.57
IP 4, 35.5, 20.2
IP 5, 9999, 9999
```

IW – Bottom Width and Side Slope

Purpose	Used to provide the geometric details of the channel shape for a trapezoidal channel.
Format	IW m.mmm, n.nnn
Range	m = Bottom Width (0 to 500 m), n Side Slope (run/rise)
Default	IW 5.000, 1.000

Recommended Setting. Set using *WinHADCP*.

Description the first value is the width of the bottom of the channel in meters. The second value is the slope of the sides as rise/run. The first value is used for trapezoidal and rectangular channels. The second value applies only for trapezoidal channels.

10.5.2 Computation Commands

The Index Velocity and Discharge Commands Computation commands IB, IS, and IV are used to compute the index velocity (rated mean velocity based on the Channel Master's velocity profile data).

IB - Bank

Purpose — Used to indicate whether the Channel Master is mounted on the left bank or right bank.

Format — IBn

Range — n = 0 (left), 1 (right)

Default — IB1

Recommended Setting. Set using *WinHADCP*.

Description — the IB command is used to indicate whether the Channel Master is mounted on the left bank or right bank of the channel. This is necessary since the Channel Master outputs negative velocity for downstream flow if the Channel Master is mounted on the left bank.

IS - Select Velocity Bins

Purpose — Used to select the cells that are averaged as part of the input to compute the rated mean velocity.

Format — IS n, B (IS0 = help)

Range — n = 1 to 99
B = desired Bin number (1 to 255)
last entry B = 9999

Default — IS 1,9999

Recommended Setting. Set using *WinHADCP*.

Description — The IS command is used to select the cells that are to be averaged as part of the input to compute the rated mean velocity. It is possible to select a range of cells or a list of individual cells.

To select a continuous range of cells, use the command IS 100, B1, B2. Here, 100 indicates that a range of cells from B1 to B2 are to be used. Therefore, the command IS 100, 1, 20 selects all cells from 1-20 to be averaged together.

To select a list of cells, the list is input using IS n, B where 'n' is the position in the list and B is the cell number. Input the list one cell at a time. The last cell is designated by entering 9999 for the bin number. For example entering the following will select cells 1, 3, 5, and 7 to be averaged.

```
IS 1, 1
IS 2, 3
IS 3, 5
IS 4, 7
IS 5, 9999
```

IV – Velocity Equation Constant

Purpose	Sets the constants for the index velocity rating.
Format	IV C1, C2, C3
Range	C1 = -5 to 5, C2 = -5 to 5, C3 = -10 to 10
Default	IV 0.000, 1.000, 0.000

Recommended Setting. Set using *WinHADCP*.

Description The IV command is used to enter the constants for the index velocity rating using the equation:

$V_{index} = C1 + (C2 + C3 * H) * V_{avg}$

Where H is the stage of the channel and V_{avg} is the average velocity of the cells selected using the IS command.

10.5.3 Output Commands

The following Index Velocity and Discharge Commands are used to set parameters used to control the output of the computed, flow, area, etc.

IF - Flag Counter

Purpose	Sets how long to use the last good velocity and vertical range data for discharge calculation when invalid data is measured.
Format	IFn
Range	n = 1 to 100
Default	IF10

Recommended Setting. The default setting for this command is recommended for most applications.

Description The Channel Master calculates cumulative volume by calculating a volume for each ensemble and adding it to the total. If a momentary problem causes a few ensembles to have invalid data, the volume is calculated from the last good data. The IF command sets the number of ensembles to hold the last good data. If the problem persists longer than this, the cumulative volume and other discharge values are not calculated or updated until more valid data is measured.

IO - Q Calculation

Purpose	The IO commands enables and disables flow computation.
Format	IO n
Range	n = 0 (off), 1 (on)
Default	IO 1

Recommended Setting. Set using *WinHADCP*.

Description The IO commands enables/disables computation and output of flow, area, volume, and stage.

IU - Output Units

Purpose	Selects the output units to be used.
Format	IU Velocity, Discharge, Volume, Area, Stage
Range	See description
Default	IU 1, 1, 1, 1, 1

Recommended Setting. Set using *WinHADCP*.

Description The IU command selects the units to be used for the output of velocity, discharge, volume, area, and stage via, RS-232/422 ASCII output or via SDI-12, as well as internally recorded data. The various possible selections are:

Velocity Units:
1 = Meters per second
2 = Feet per second
3 = Centimeters per second

Discharge Units:
1 = Cubic meters per second
2 = Cubic feet per second (cfs)
3 = Liters per second
4 = Gallons per minute
5 = Million gallons per day (mgd)
6 = Million liters per day

Volume Units:
1 = Cubic meters
2 = Cubic ft
3 = Gallons
4 = Acre-ft
5 = Liters
6 = Thousand gallons
7 = Million gallons

Area Units:
1 = Square meters
2 = Square ft

Stage Units:
1 = meters
2 = ft

NOTE. The IT command can modify some of the volume units.

IT - Output Exponent

Purpose The IT command allows a scaling factor to be applied to the output of discharge and volume, respectively.

Format IT n1,n2

Range n1,n2 = 0 to 6

Default IT 0,0

Recommended Setting. Set using *WinHADCP*.

Description

Volume and discharge can be inconveniently large numbers. For example, the SDI-12 protocol does not permit more than seven digits in a single number. The scale factors shifts the decimal point up to six places to the left. This effectively provides more units than the IU command alone does. For example, suppose the volume is 12345678.9 cubic feet. If the IT command is set to 3, this would become 12345.67 kilo cubic feet.

The IT command depends on the IU command (see "IU - Output Units," page 69). The IT command only changes the volume if IU has set the volume unit to:

1 = Cubic meters
2 = Cubic ft
3 = Gallons

The discharge exponent is applied for all discharge units.

NOTE. In order to be able to correctly interpret output at a later time, you should make careful records of the units and scale factors that you selected above.

IZ - Zero Volume Accumulator

Purpose — Resets or displays the cumulative volume.

Format — IZ ZeRo (Reset to zero)
IZ ? (Display cumulative volume)

Range — N/A

Default — N/A

Recommended Setting. Use as needed. Reset using *WinHADCP*.

Description

IZ ZeRo resets the cumulative volume to zero. This command is case sensitive and must be entered exactly as shown. Use "IZ ?" to display the cumulative volume in cubic meters.

Some instruments cannot handle values larger than one million. For this reason, the cumulative volume is split into two numbers. The first number is the millions part of the volume. The second part is the rest of the volumn.

For example a volume of 12,345,678.90 cubic meters would be reported as the following:

```
iz 12, 345678.90 ------ -----. zeRo Volume Accumulator
```

10.6 Loop Recorder Commands

The loop recorder contains approximately two megabytes of solid-state nonvolatile memory, which can be used to continuously record data. If more data is collected than fits in the memory, the oldest data will be over-written with the newest data. You always have up to the last two megabytes of data available for download.

```
>M?
Available Commands:

ME ---------------------- ErAsE recoder
MM ---------------------- Show memory usage
MN CHM - Set file name [1..32 characters]
MR 0 -------------------- Set recorder on/off [0=off,1=on]
MY ---------------------- Y-Modem output
M? ---------------------- Display M-Command Menu
```

10.6.1 Loop Recorder Command Descriptions

This section lists the Loop Recorder commands.

ME – Erase Recorder

Purpose Erase the contents of the loop recorder.

Format ME ErAsE

Recommended Setting. Use as needed.

Description ME ErAsE erases the recorder memory. To make it more difficult to accidentally erase the data, the word “erase” must be typed with exactly one space after the “ME” (which is not case sensitive) and with alternating upper and lower case letters, as shown.

```
>ME ErAsE
[ERASING...]
```

CAUTION. Once erased, data is not recoverable.

MM – Show Memory Usage

Purpose Shows recorder memory usage.

Format MM

Recommended Setting. Use as needed.

Description Shows memory usage and the number of used and free pages.

```
MM  Loop Recorder pages: used = 0, free = 4096, bytes/page = 528

>
```

MN – Set File Name

Purpose	Sets the file name for the recorder.
Format	MN *xxx*
Range	*xxx* = file name up to 32 characters long
Default	MN CHM

Recommended Setting. Use as needed.

Description The MN command sets the deployment name to be used for any future deployments. The deployment name can be up to 32 characters long, and may contain letters, numbers, or the underscore (i.e. "_") character. If no deployment name is specified, a default of "CHM" is used. The deployment name is used as part of the file name for data files when downloaded to the computer using *BBTalk* (see "Recovering Data from the Loop Recorder," page 15).

In order to prevent data files on the computer from being overwritten, a ten-digit time stamp is appended to the file name when **OK** is clicked on the **Download Directory** dialog box (see Figure 9, page 16).

For example, the file *CHM3281997475.000* would contain data for the deployment named "CHM" (the *3281997475* in the filename is the number of seconds since January 1st, 1900). The file extension is always ".000". If you wait 25 seconds and download the same data again, the file name will change to *CHM3281997500.000.*

MR – Set Recorder On/Off

Purpose	Turns the recorder on or off.
Format	MR*n*
Range	*n* = 0, turn recorder off; *n* = 1, turn recorder on)
Default	MR0

Recommended Setting. Use as needed.

Description Use the MR command to turn the recorder on/off.

MY – Y-Modem Output

Purpose — Uploads recorder data to a host computer using standard YMODEM protocol.

Format — MY

Recommended Setting. Use WinHADCP or *BBTalk* to recover data (see "Recovering Data from the Loop Recorder," page 15).

Description — Use the MY command to recover data from the recorder only when *BBTalk* is not available to recover the data.

RY uploads the entire contents of the recorder via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. Any communications program that uses the YMODEM protocol may be used to upload the recorder data. The data is transferred to the host and stored as DOS files.

10.7 Performance and Testing Commands

The Channel Master uses the following commands for calibration and testing.

```
P?
Available Commands:

PA ---------------------- Run Go/No-Go Tests
PC ---------------------- Built In Tests [0=help]
PD  0 ------------------- Data Stream Select
PS ---------------------- System Info [0=config,1=fldr,2=vldr,4=pings]
PT ---------------------- Built In Tests, PT 0 = Help
P? ---------------------- Display P-Command Menu
```

10.7.1 Performance and Testing Command Descriptions

This section lists the Performance and Testing commands.

PA – Pre-deployment Tests

Purpose — Sends/displays results of a series of Channel Master system diagnostic tests.

Format — PA

> **Recommended Setting.** Use as needed.

Description — These diagnostic tests check the major Channel Master modules and signal paths. We recommend you run this command before a deployment. These tests check the following boards/paths.

- CPU - CPU RAM and real-time clock.
- DSP - RAM, registers, and DSP-to-CPU Communications.

Example

```
>PA
RAM test...........PASS
GO
>
```

PC – User-Interactive Built-In Tests

Purpose — Sends/displays results of user-interactive Channel Master system diagnostic tests.

Format — PC*nnn*

Range — *nnn* = 0, 2, 4 (PC0 = Help menu; see below for others)

> **Recommended Setting.** Use as needed.

Description — These diagnostic tests check beam continuity and sensor data.

Examples — See below.

PC0 – Help Menu

Sending **PC0** displays the help menu.

```
>PC0
PC0           = Help
PC2           = Display Sensor Data
PC4           = Surface Track Ping - Advanced
>
```

PC2 – Display Sensor Data

PC2 makes measurements once a second. Lines of data end with a carriage return so *BBTalk* prints successive lines on top of each other. PC20 is just like PC2 except that lines end with a carriage return and a line feed. *BBTalk* scrolls with this command.

```
>PC2
Sensor data is sampled and displayed in a loop.
An asterisk '*' to the right of a number indicates invalid data.
Press any key to exit the loop.

Temp(degC)   Press(kPa)   Press(m) Pitch(deg) Roll(deg)    Batt(V)
\     18.21       4.202     0.429       5.66     -0.42      9.281
/     18.21       4.206     0.429       5.66     -0.42      9.289
\     18.21       4.187     0.427       5.66     -0.42      9.281
/     18.21       4.193     0.428       5.67     -0.43      9.281
```

NOTE. Use the ST command to change the units for the temperature (see "ST – Temperature Units," page 81).

```
>ST?
ST C -------------------- Set temperature units (0=c; 1=f; 2=k)
>ST1
>PC2
Sensor data is sampled and displayed in a loop.
An asterisk '*' to the right of a number indicates invalid data.
Press any key to exit the loop.

Temp(degF)   Press(kPa)   Press(m) Pitch(deg) Roll(deg)    Batt(V)
\     64.78       4.189     0.427       5.66     -0.43      9.281
/     64.78       4.179     0.426       5.67     -0.43      9.281
\     64.78       4.197     0.428       5.66     -0.43      9.281
/     64.78       4.192     0.428       5.66     -0.42      9.281

>ST2
>PC2
Sensor data is sampled and displayed in a loop.
An asterisk '*' to the right of a number indicates invalid data.
Press any key to exit the loop.

Temp(degK)   Press(kPa)   Press(m) Pitch(deg) Roll(deg)    Batt(V)
\    291.36       4.204     0.429       5.66     -0.42      9.289
/    291.36       4.199     0.428       5.67     -0.43      9.281
\    291.36       4.194     0.428       5.66     -0.42      9.281
/    291.36       4.192     0.428       5.66     -0.42      9.281
```

PC4 – Surface Track Ping

PC4 displays the corrected/uncorrected range. Normally the corrected/uncorrected ranges are the same. In some cases, the range may be corrected for a frequency offset in an internal oscillator.

```
>PC4
Uncorrected/Corrected Range =   2330   2330
>
```

PD – Data Stream Select

Purpose: Selects the type of ensemble output data structure.

Format: PDn

Range n = 0, 14, 19 (see description)

Default PD0

Recommended Setting. The default setting for this command is recommended for most applications. PD14 and PD19 are used for integration of the Channel Master with other systems or data loggers.

Description: The PD command selects the normal output data structure, a special application data structure, or a fixed data set for transmission/display as the data ensemble (see Table 14).

Table 14: Data Stream Selections

Format	Description
PD0	Sends The real water-current data set
PD1 to PD13	Not used.
PD14	Send the Channel Master Condensed 2D Output Format
PD15 to PD18	Not used.
PD19	Sends discharge data in an NMEA-like ASCII format

NOTE. *WinHADCP* supports PD0, PD14, and PD19.

PS – Display System Parameters

Purpose Sends/displays Channel Master system configuration data.

Format PS*n*

Range *n* = 0 (see description)

Recommended Setting. Use as needed.

Description See below.

PS0 – System Configuration

PS0 sends the Channel Master hardware/firmware information. For example, the output may look like this:

```
>PS0
   Serial Number:  5813
       Frequency:  1228800 Hz
   Configuration:  HADCP: 2-beam velocity + vertical stage.
 Transducer Type:  PISTON
      Beam Angle:  20 Degrees
    Beam Pattern:  CONVEX
         Sensors:  TEMP  PRESS  TILTS
```

```
 Product Version:  CM02.04
    CPU Firmware:  28.28f
    FPGA Version:  2.00.003
     Sensor Boot:  32.02
 Sensor Firmware:  33.03

Board Serial Number Data:
 24 00 00 00 32 23 40 23   SNS72B-1000-00A
 15 00 00 00 31 65 DC 23   PIO72B-2001-00B
 A8 00 00 00 10 66 B6 23   XDR71B-1007-00A
 E3 00 00 00 1F CD 99 23   PER72B-2006-00X
 DC 00 00 00 31 CA 43 23   RCV72B-2003-09A
 90 00 00 00 31 AB 7F 23   DSP72B-2002-00A
>
```

PS1 – Fixed Leader

PS1 sends the Fixed Leader parameters (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see Figure 27, page 101). For example, a Hex-ASCII output may look like this:

```
>PS1
3B00001C0D4C21003502320A0019001900014803 00E8030000320A941100007D2D3D0023000101FF000C000
0000000000000000000000DC1200001914
>
```

NOTE. The output format of the PS1 command is determined by the CF command (see "CF – Flow Control," page 54).

PS2 – Variable Leader

PS2 sends the Variable Leader parameters (i.e., variable system commands and sensor readings) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see Figure 28, page 106). For example, a Hex-ASCII output may look like this:

```
>PS2
3D8000130004031E1032035200000D005000000000505A40D0000BD0833005F0000000000000000000000000
00000000000FFFFFFFF0000000000000000FA14
>
```

NOTE. The output format of the PS1 command is determined by the CF command (see "CF – Flow Control," page 54).

PS4 – Ping Sequence

PS4 sends an ASCII representation of the ping sequence generated by the WP and VP commands (see "WP – Pings per Ensemble," page 94, "VP – Vertical Beam Number of Pings per Ensemble," page 88 and "TP – Time Between Pings," page 85 for explanation of ping sequence). For example:

```
>PS4
Ping Sequence:  WV

>WP?
WP 001 ------------------ Number of Pings
>VP?
VP 001 ------------------ Number of Pings per Ensemble (<100)
>PS4
Ping Sequence:  WV

>WP5
>VP3
>PS4
Ping Sequence:  W WV WV W WV

>WP3
>VP0
>PS4
Ping Sequence:  W W W
```

PT - Built-In Tests

Purpose	Sends/displays results of Channel Master system diagnostic test.
Format	PT*nnn*
Range	*nnn* = PT0, PT103, PT200, PT3 (see below)

Recommended Setting. Use as needed.

PT0 - Help

Displays the test menu (shown below). Sending PT103 will repeat the PT3 test continually until the Channel Master receives a <BREAK>. Sending PT200 runs all tests.

```
>PT0
Built In Tests
---------------
PT0 = Help
PT3 = Receive Path
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 - Receive Path

This test displays receive path characteristics. This test is for expert users. The test is done once for each combination of high and low gain and high and low bandwidth. Even though there are only three transducers, the Channel Master contains electronics to support four beams. Beams 1 and 2

are the horizontal water profiling beams. Beam 4 is the vertical beam. Beam 3 is unused electronics. The test contains four parts.

Part 1 - The Channel Master pings without transmitting and displays the result of an autocorrelation function performed on the received ambient sound and internal electrical noise over 15 lag periods. Lag time can be calculated from the sample rate at the bottom line of the output. Lag = 1/sample rate.

The receive path contains a band-pass filter that limits the correlation time of the received signal for beams 1 and 2 to a few lag times. Longer correlation times indicate a problem such as interference from a radio station. Beams 3 and 4 cannot be so easily interpreted because of electrical and frequency differences.

Part 2 - The received signal is split into two parts and hard limited into 1's and 0's. A random signal should have about 50% of each. A duty cycle much different from 50% is an indication of a problem.

Part 3 - Random electrical noise sampled at two different times have some level of correlation. This correlation is called the noise floor. It can be seen at the tail end of the 15 lags.

A higher than usual noise floor may indicate the presence of a signal that self correlates better than random noise or a hardware problem. The noise floor should be higher at high gain and lower at low gain. Too small a difference can indicate a problem in the demodulator, receiver, or RSSI switching circuitry.

Part 4 - For beams 1 and 2, the bandwidth of the band-pass filter can be calculated by integrating correlation over lag times.

```
>PT3
Receive Path Test (Hard Limited):
         H-Gain W-BW         L-Gain W-BW         H-Gain N-BW         L-Gain N-BW
Correlation Magnitude (percent)
Lag Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4     Bm1 Bm2 Bm3 Bm4
  0 100 100 100 100     100 100 100 100     100 100 100 100     100 100 100 100
  1  83  83  86  85      80  79  79  90      79  81  81  93      78  77  78  93
  2  51  51  55  70      46  41  41  71      43  44  45  79      42  41  41  77
  3  24  26  28  49      18  15  16  49      16  18  19  61      16  16  15  57
  4   9  13  12  33       6   2   3  28       3   3   7  43       6   5   5  38
  5   5   8   6  20       2   0   4  14       2   3   6  30       5   3   6  22
  6   5   6   5  10       4   2   5   4       1   4   6  20       3   3   7  10
  7   5   6   5   6       4   1   3   3       3   3   6  13       1   1   6   3
  8   4   5   4   4       2   3   1   6       4   1   5  10       2   2   3   4
  9   3   3   4   4       1   4   2   6       4   4   1   8       5   2   2   7
 10   2   2   4   3       2   4   3   7       3   5   2   8       7   1   2   8
 11   3   3   4   6       2   5   3   8       0   5   2   9       6   1   2   7
 12   1   5   4   5       4   6   3   8       2   3   3  11       6   3   3   5
 13   0   4   3   4       5   6   3   7       2   1   2  12       6   5   3   3
 14   2   3   3   4       6   8   2   6       2   1   3  12       6   3   5   1
 15   1   3   2   5       5   7   3   5       4   1   4  13       3   3   6   1
Sin Duty Cycle (percent)
     44  49  50  54      51  52  51  54      46  51  52  65      51  52  51  54
Cos Duty Cycle (percent)
     51  48  50  54      51  49  50  51      49  48  53  62      51  52  53  58
RSSI Noise Floor (counts)
     66  50  66  62      57  41  57  52      73  58  74  70      57  41  57  52
BandWidth (kHz)
    369 350 347 293     379 383 394 291      99  97  94  60      94 100  95  70
Sample Rate (Hz)
            1228800             1228800             307200              307200
```

10.8 Sensor Commands

The following commands let you set the sensor functions.

```
>S?
Available Commands:

ST C -------------------- Set temperature units (0=c; 1=f; 2=k)
SZ ---------------------- Zero Pressure Sensor
S? ---------------------- Display S-Command Menu
```

10.8.1 Sensor Command Descriptions

This section lists the sensor commands.

SZ – Zero Pressure Sensor

Purpose Zeros the pressure sensor.

Format SZ

Recommended Setting. Use as needed.

Description This command zeros the pressure sensor at the specific location where the Channel Master will be used.

ST – Temperature Units

Purpose Sets the units for the temperature sensor in the PC2 test.

Format STn

Range n = 0 (Celsius), 1 (Fahrenheit), 2 (Kelvin)

Default ST0

Description Sets the units for the temperature sensor as output by the PC2 command (see "PC2 – Display Sensor Data," page 76).

NOTE. This command does not change the temperature units in the Variable Leader Data (see Figure 28, page 106).

10.9 Timing Commands

The following commands let you set the timing of various profiling functions.

```
>T?
Available Commands:

TD 00:20:00.00 ---------- SDI-12 Watchdog timer reset
TE 00:00:05.00 ---------- Time Between Ensembles
TF 00/00/00,00:00:00 ---- Set First Ping Time (yy/mm/dd,hh:mm:ss)
TP 00:00.60 ------------- Time Between Pings
TS 06/01/24,10:45:57.95 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/24,10:45:57.95 - Stored Time
T? ---------------------- Display T-Command Menu
```

10.9.1 Standard Timing Command Descriptions

This section lists the Timing commands.

TD – Built-In Watchdog Timer

Purpose: Sets the reset time period (TD) from the user-entered time on the command line. The user must enter the TD time as eight digits, with or without delimiters.

Format: TDhh:mm:ss.ff (acceptable formats include: TDhhmmssff, TDhh:mm:ss.ff, or TDhh mm ss ff)

Range: hh = 00 to 23 hours

mm = 00 to 59 minutes

ss = 00 to 59 seconds

ff = 00 to 99 hundredths of seconds

Default: TD00:20:00.00

Recommended Setting. Set TD to a duration longer than the SDI-12 measurement interval. Do not set it close to the actual SDI-12 measurement interval as this could possibly cause unwanted resets just at the time the next measurement request is occurring.

Description: If the Channel Master fails to respond to an SDI-12 measurement request, the TD command will reset the Dual UART circuitry in the Channel Master. This will allow the Channel Master to continue responding to subsequent measurements although the last missed request will be lost.

The TD command should be set to an interval that's a few minutes longer than the expected time between SDI-12 measurements. If the SDI-12 measurement interval is 15 minutes, set the TD value to 20 to 25 minutes; do not set the timer to 15 minutes.

TE – Time Per Ensemble

Purpose	Sets the time interval between data collection cycles (data ensembles).
Format	TE*hh:mm:ss.ff*
Range	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TE 00:00:05.00

Recommended Setting. Set using *WinHADCP*.

Description

The TE command sets the time between the start of one ensemble and the start of the next. If TE is very short, the Channel Master will generate the next ensemble as soon as the last ensemble completes. The time needed to complete an ensemble is controlled by the number of pings (WP, VP) and time between pings (TP).

Min Ensemble time = (WP + VP - 1) x TP + Overhead

= WP x TP (approximately)

Overhead is the time needed to process and save the data. It is typically less than a second, especially for high BAUD rates or few cells. The time needed to complete a ping may be longer than the TP command; For example, setting the TP command to TP00:00.00 will cause the next ping to be transmitted immediately after the last ping completes.

Example

TE01:15:30.00 tells the Channel Master to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

NOTES.

The time tag for each ensemble is the time of the first ping of that ensemble, not the time of output.

For SDI-12, the data logger tells the Channel Master when to generate an ensemble. TE is ignored.

TF – Time of First Ping

Purpose	Sets the time and date the Channel Master wakes up to start data collection.		
Format	TF*yy/mm/dd, hh:mm:ss*		
Range	*yy*	= year	00-99
	mm	= month	01-12
	dd	= day	01-31 (leap years are accounted for)
	hh	= hour	00-23
	mm	= minute	00-59
	ss	= second	00-59

Recommended Setting. Set using *WinHADCP*.

Description TF delays the start of data collection. This lets you deploy the Channel Master in the Standby mode and have it automatically start data collection at a preset time (typically used in battery operated instruments). When the command is given to the Channel Master to start pinging, TF is tested for validity. If valid, the Channel Master sets its alarm clock to TF, goes to sleep, and waits until time TF before beginning the data collection process.

Example If you want the exact time of the first ping to be on November 23, 1992 at 1:37:15 pm, you would enter TF92/11/23, 13:37:15. If you want the Channel Master to begin pinging immediately after receiving the CS-command (see notes), do not enter a TF-command value.

NOTES.

1. Although you may send a TF-command to the Channel Master, you also must send the CS-command before deploying the Channel Master.
2. If the entry is not valid, the Channel Master sends an error message and does not update the wake-up time.
3. Sending a <BREAK> clears the TF time.

TP – Time Between Pings

Purpose	Sets the time interval between pings in an ensemble.
Format	TP*mm:ss.ff*
Range	*mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	TP00:00.60

Recommended Setting. Set using *WinHADCP*.

Description	The TP command sets the time interval between the start of one ping and the start of the next within an ensemble. If TP is very short, the Channel Master will generate the next ping as soon as the last ping completes. The time needed to complete a ping may not be easy to predict. It is controlled by sound propagation time (speed of sound x max range x 2), processing overhead, and other factors. The max range is controlled by commands (WF, WN, WS) and the environment (for example, range to the surface for the vertical beam). The vertical beam ping consists of multiple sub-pings.
Example	TP00:00.10 sets the time between pings to 0.10 second.

NOTE. The Channel Master automatically increases TE if WP x TP > TE.

TS – Set Real-Time Clock

Purpose	Sets the Channel Master's internal real-time clock.		
Format	TS*yy/mm/dd, hh:mm:ss*		
Range	*yy*	= year	00-99
	mm	= month	01-12
	dd	= day	01-31
	hh	= hour	00-23
	mm	= minute	00-59
	ss	= second	00-59

Recommended Setting. Set using *WinHADCP*.

Description Use the TS command to set the Channel Master's internal clock. Sending TS? displays two times. Usually they are identical, but the first time after power up, TS? displays the current time and the time power was removed.

```
>ts?
TS 06/01/30,10:29:41.14 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/30,10:29:24.00 - Stored Time
>ts?
TS 06/01/30,10:29:46.39 - Set System Date and Time (yy/mm/dd,hh:mm:ss)
   06/01/30,10:29:46.39 - Stored Time
```

Example TS06/06/17, 13:15:00 sets the real-time clock to 1:15:00 pm, June 17, 2006.

NOTES.

When the Channel Master receives the carriage return after the TS- command, it enters the new time into the real-time clock and sets hundredths of seconds to zero.

The internal clock *does* account for leap years.

If the entry is not valid, the Channel Master sends an error message and does not update the real-time clock.

10.10 Vertical Beam Commands

The following commands define the criteria used to set the Vertical Beam data.

```
>V?
Available Commands:

VD 111000000 ------------ Data Out {a;c;s;*;*;*;*;*;*}
VF 0005 ----------------- Blank (cm)
VP 001 ------------------ Number of Pings per Ensemble (<100)
V? ---------------------- Display V-Command Menu
```

10.10.1 Vertical Beam Command Descriptions

This section lists the Vertical Beam commands.

VD – Vertical Beam Data Out

Purpose — Selects the vertical beam data types included in a PD0 ensemble.

Format — VD *abcdefghi*

Range — Firmware switches (see description)

Default — VD 111000000

Recommended Setting. The default setting for this command is recommended for most applications.

Description — The VD command uses firmware switches to tell the Channel Master the types of vertical beam data to include in a PD0 ensemble. PD0 ensembles always contain a header, fixed and variable leader, and checksum. The bits are described as follows:

a = surface track amplitude	*d* = Reserved	*g* = Reserved
b = surface track commands	e = Reserved	*h* = Reserved
c = surface track status	*f* = Reserved	*I* = Reserved

Example — VD 111000000 (default) tells the Channel Master to include surface track amplitude, surface track commands, and surface track status.

NOTE.

1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
2. IF VP = zero, the Channel Master does not collect vertical beam data, and VD has no effect (see “VP – Vertical Beam Number of Pings per Ensemble,” page 88). No vertical beam data is included.
3. The VD command does not affect the contents of PD14, PD19, or SDI-12 data.
4. See the WD command for water profile and firmware version data (see “WD – Data Out,” page 92).

VF – Vertical Beam Blank after Transmit

Purpose Moves the start of the search away from the transducer head.

Format VF*nnnn*

Range *nnnn* = 5 to 9999 cm (328 feet)

Default VF0005

Recommended Setting. The default setting for this command is recommended for most applications.

Description Set the VF command to start the search for the surface to some distance after transmit to avoid adjacent structures or to allow transmit recovery.

VP – Vertical Beam Number of Pings per Ensemble

Purpose Sets the number of pings per ensemble.

Format VP*nn*

Range *nn* = 0 to 99 pings

Default VP1

Recommended Setting. The default setting for this command is recommended for most applications.

Description This is similar to the WP command. Unlike horizontal beam pings, vertical beam pings contain multiple sub-pings. This means vertical beam pings take longer, but produce higher resolution and better averaged data than they otherwise would.

NOTE. IF VP = zero, the Channel Master does not collect vertical beam data, and the VD command will have no effect (see “VD – Vertical Beam Data Out,” page 87). No vertical beam data (Surface track amplitude, surface track commands, and surface track status) will be included in the output data.

10.10.2 Expert Level Vertical Beam Command Descriptions

The following expert commands define the criteria used to set the Vertical Beam data.

#VC – Detection Filter, Pressure & Range Screening Control

Purpose
1. Controls the surface detection filter that is applied to average RSSI data.
2. Controls whether the pressure sensor will be used as a first guess in detecting the surface.
3. Controls the percent of range used in screening pings within a burst.

Format
#VC *m p rrr*

Range
m = 0 to 2
p = 0 or 1
rrr = 0 to 100 %

Default
#VC 0 0 25

Recommended Setting. The default setting for this command is recommended for most applications.

Description: See below.

If *m* = 0, the 'W' filter is used on average data. If *m* = 1, the leading edge filter is used on average data. If *m* = 2, the 'W' filter and then the leading edge filter is used on average data.

If *p* = 0, then the pressure sensor is not used. If *p* = 1, then the pressure sensor is used. Using the pressure sensor can reduce ping time and avoid false detection. Set the #VS command to 1 or 2 sub-pings for an improved ping rate if the pressure sensor is used.

The value set by the *rrr* digits determines the allowable difference of individual pings' range from the average range over a burst. The allowable difference is ±*rrr*, so the window is twice *rrr*. Screening the individual pings in this way is an effective means of avoiding false detection.

NOTE. For information on other expert level vertical beam commands, see FST-006 (available for download on www.rdinstruments.com) or contact Teledyne RDI (see "Technical Support," page 137).

10.11 Water Profiling Commands

The following commands define the criteria used to collect the water-profile data.

```
>W?
Available Commands:

WA 255 ------------------ False Target Amplitude Threshold [0-255]
WB 0 -------------------- Bandwidth 0=High, 1=low
WC 072 ------------------ Correlation Threshold [0-255]
WD 111110000 ------------ Data Out {v;c;a;p;s;*;*;*;*}
WF 0050 ----------------- Blanking Distance (cm)
WN 025 ------------------ Number of Bins [0-255]
WP 001 ------------------ Number of Pings
WS 0100 ----------------- Bin Size (cm)
WV 0175 ----------------- Ambiguity Velocity (cm/s)
W? ---------------------- Display W-Command Menu
```

10.11.1 Water Profiling Command Descriptions

This section lists the Water Profiling commands.

WA – False Target Threshold Maximum

Purpose	Sets a false target (fish) filter.
Format	WA*nnn*
Range	*nnn* = 0 to 255 counts (255 disables this filter)
Default	WA255

Recommended Setting. The default setting for this command is recommended for most applications.

Description The Channel Master uses the WA-command to screen water-track data for false targets (usually fish). WA sets the maximum difference between echo intensity readings among the profiling beams. If the WA threshold value is exceeded, the Channel Master rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.

NOTE. A WA value of 255 turns off this feature.

WB – Mode 1 Bandwidth Control

Purpose — Sets profiling mode 1 bandwidth (sampling rate). Low bandwidth allows the Channel Master to profile farther, but the standard deviation is increased by as much as 2.5 times.

Format — WB*n*

Range — *n* = 0 (High), 1 (Low)

Default — WB0

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description — The *WB*-command influences profiling range. If you narrow the bandwidth of the system, the profiling range is increased. See table below.

Table 15: Bandwidth Control

Bandwidth	Sample rate	Data variance	Profiling range
0 = High	High	Low	Low
1 = Low	Low	High	High

WC – Low Correlation Threshold

Purpose — Sets the minimum threshold of water-track data that must meet the correlation criteria.

Format — WC*nnn*

Range — *nnn* = 0 to 255 counts

Default — WC072

> **Recommended Setting.** The default setting for this command is recommended for most applications.

Description — The Channel Master uses WC to screen water-track data for the minimum acceptable correlation requirements. WC sets the threshold of the correlation below, which the Channel Master flags the data as bad and does not average the data into the ensemble.

> **NOTE.** The default threshold for all frequencies is 72 counts. A solid target would have a correlation of 255 counts.

WD – Data Out

Purpose	Selects the water profile data types included in a PD0 ensemble.
Format	WD *abcdefghi*
Range	Firmware switches (see description)
Default	WD 111110000

Recommended Setting. The default setting for this command is recommended for most applications.

Description The WD command uses firmware switches to tell the Channel Master the types of velocity profile data and firmware version data to include in a PD0 ensemble. PD0 ensembles always contain a header, fixed and variable leader, and checksum.

a = Velocity	*d* = Percent good	*g* = Reserved
b = Correlation	e = Status and Firmware Version	*h* = Reserved
c = Echo Intensity	*f* = Reserved	*I* = Reserved

Example WD 111110000 (default) tells the Channel Master to include velocity correlation, echo intensity, percent good, status, and firmware version.

NOTES.

1. Each bit can have a value of one or zero. Setting a bit to one means output data, zero means suppress data.
2. The WD command does not affect the contents of PD14, PD19, or SDI-12 data.
3. IF WP = zero, the Channel Master does not collect water track data, and therefore WD would only affect the firmware version output. No water track data is included (see "WP – Pings per Ensemble," page 94).
4. See the VD command for vertical beam data (see "VD – Vertical Beam Data Out," page 87).
5. If the Status bit is set to zero, this disables both the status data and the firmware version (see "Firmware Version Data Format," page 115).

WF – Blank after Transmit

Purpose — Moves the location of first cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format — WF*nnnn*

Range — see table

Frequency	Minimum	Maximum
300 kHz	10 cm	9999 cm (328 feet)
600 kHz	5 cm	9999 cm (328 feet)
1200 kHz	5 cm	9999 cm (328 feet)

Default — WF0050 (1200 kHz), WF0100 (600 kHz), WF0200 (300 kHz)

Recommended Setting. The default setting for this command is recommended for most applications.

Description — WF positions the start of the first cell at some vertical distance from the transducer head. This allows the Channel Master transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

NOTES.

1. The distance to the middle of cell #1 is a function of blank after transmit (WF), cell size (WS), and speed of sound. The fixed leader data contains this distance.

2. Small WF values may show ringing/recovery problems in the first cells that cannot be screened by the Channel Master.

WN – Number of Cells

Purpose — Sets the number of cells over which the Channel Master collects data.

Format — WN*nnn*

Range — *nnn* = 001 to 255 cells

Default — WN025

Recommended Setting. Set using *WinHADCP*.

Description — The range of the Channel Master is set by the number of cells (WN) times the size of each cell (WS).

WP – Pings per Ensemble

Purpose Sets the number of pings to average in each data ensemble.
Format WP*nnnnn*
Range *nnnnn* = 0 to 999 pings
Default WP00001

Recommended Setting. Set using *WinHADCP*.

Description WP sets the number of pings to average in each ensemble before sending/recording the data.

NOTE. If WP = zero the Channel Master does not collect water-profile data.

The WP command affects the minimum ensemble interval (see "TE – Time Per Ensemble," page 83).

WS – Cell Size

Purpose Selects the volume of water for one measurement cell.
Format WS*nnnn*
Range see table
Default see table

Frequency	Range	Default
300 kHz	100 to 1000 cm	WS0400
600 kHz	100 to 800 cm	WS0200
1200 kHz	10 to 400 cm	WS0100

Recommended Setting. Set using *WinHADCP*.

Description The Channel Master collects data over a variable number of cells. WS sets the size of each cell in centimeters.

WV – Ambiguity Velocity

Purpose	Sets the radial ambiguity velocity.
Format	WV*nnn*
Range	*nnn* = 000 to 999 cm/s
Default	WV175

Recommended Setting. It is strongly recommended that the WV command be left at the default value of 175.

Description

Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. RDI recommends that the WV command not be set below 100cm/s. Rule of thumb: Set WV to the maximum horizontal velocity relative to the Channel Master.

The WV command (ambiguity velocity setting) sets the maximum velocity that can be measured along the beam. WV is used to improve the single-ping standard deviation. The lower the value of the WV command is, the lower the single-ping standard deviation.

11 Channel Master PD0 Output Data Format

This section shows the output data format of the Channel Master. Channel Master output data can be in either hexadecimal-ASCII or binary format. You can select this option through the CF-command (see the "CF – Flow Control," page 54). We explain the output data formats in enough detail to let you create your own data processing or analysis programs (see "How to Decode a Channel Master Ensemble," page 127).

The following description is for the standard PD0 Channel Master output data format. Figure 26, page 98 through Figure 34, page 123 shows the ASCII and binary data formats for the Channel Master PD0 mode. Table 17, page 99 through Table 30, page 123 defines each field in the output data structure.

After completing a data collection cycle, the Channel Master immediately sends a data ensemble. The following pages show the types and sequence of data that you may include in the Channel Master output data ensemble and the number of bytes required for each data type. The Channel Master sends all the data for a given type for all range cells and all beams before the next data type begins.

The Channel Master by default is set to collect velocity, correlation data, echo intensity, percent good data, and status. The data, preceded by ID code 7F7F, contains header data (explained in Table 17, page 99). The fixed and variable leader data is preceded by ID codes 0000 and 0080, (explained in Table 18, page 102 and Table 19, page 107). The Channel Master always collects Header and Leader data. The table below shows some of the most common IDs.

Table 16: Data ID Codes

ID	LSB	MSB	Description
0x7F7F	7F	7F	Header
0x0000	00	00	Fixed Leader
0x0002	02	00	Firmware Version
0x0080	80	00	Variable Leader
0x0100	00	01	Velocity Profile Data
0x0200	00	02	Correlation Profile Data
0x0300	00	03	Echo Intensity Profile Data
0x0400	00	04	Percent Good Profile Data
0x0500	00	05	Status Profile Data
0x4000	00	40	Surface Track Status
0x4001	01	40	Surface Track Commands
0x4002	02	40	Surface Track Amplitude

NOTE. The Channel Master always sends the Least Significant Byte (LSB) first.

ALWAYS OUTPUT	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (58 BYTES)
	VARIABLE LEADER DATA (60 BYTES)
WD-command WP-command	**VELOCITY** (2 BYTES + 8 BYTES PER RANGE CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER RANGE CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER RANGE CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER RANGE CELL)
	STATUS (2 BYTES + 4 BYTES PER RANGE CELL)
	FIRMWARE VERSION (39 or 50 BYTES)
VD-command VP-command	**SURFACE TRACK AMPLITUDE** (16+7*N Ping - 1 BYTE)
	SURFACE TRACK COMMANDS (28 BYTES)
	SURFACE TRACK STATUS (46 BYTES)
ALWAYS OUTPUT	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 25. PD0 Standard Output Data Buffer Format

NOTE. Some data outputs are in bytes per range cell. For example, if the WN-command (number of range cells) = 30, and the following data are selected for output, the required data buffer storage space is 1099 bytes per ensemble.

```
WD-COMMAND = WD 111 110 000 (default), WP-COMMAND = 1 (default)
VD-COMMAND = VD 111 000 000 (default), VP-COMMAND = 1 (default)
     28   BYTES OF HEADER DATA (6 + [2x Number Of Data Types])
     58   BYTES OF FIXED LEADER DATA (FIXED)
     60   BYTES OF VARIABLE LEADER DATA (FIXED)
    242   BYTES OF VELOCITY DATA (2 + 8 x 30)
    122   BYTES OF CORRELATION MAGNITUDE DATA (2 + 4 x 30)
    122   BYTES OF ECHO INTENSITY (2 + 4 x 30)
    122   BYTES OF PERCENT-GOOD DATA (2 + 4 x 30)
    122   BYTES OF STATUS DATA (2 + 4 x 30)
     50   BYTES OF FIRMWARE VERSION (with SDI)
     95   BYTES OF SURFACE TRACK AMPLITUDE DATA (16 + 7*1 - 1)
     28   BYTES OF SURFACE TRACK COMMANDS DATA
     46   BYTES OF SURFACE TRACK STATUS DATA
      2   BYTES OF RESERVED FOR RDI USE (FIXED)
      2   BYTES OF CHECKSUM DATA (FIXED)
   1099   BYTES OF DATA PER ENSEMBLE
```

NOTE. If the WD command Status bit is set to zero (WD xxx x0x xxx, then the status and firmware version outputs will be disabled. The required data buffer storage space will be reduced to 927 bytes per ensemble.

The order of data types in an ensemble is not fixed. For example, there is no guarantee that velocity data will always be output before correlation data (see “How to Decode a Channel Master Ensemble,” page 127).

11.1 Header Data Format

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	HEADER ID (7Fh)								
2	DATA SOURCE ID (7Fh)								
3	NUMBER OF BYTES IN ENSEMBLE								LSB
4									MSB
5	SPARE								
6	NUMBER OF DATA TYPES								
7	OFFSET FOR DATA TYPE #1								LSB
8									MSB
9	OFFSET FOR DATA TYPE #2								LSB
10									MSB
11	OFFSET FOR DATA TYPE #3								LSB
12									MSB
↓	(SEQUENCE CONTINUES FOR UP TO N DATA TYPES)								↓
2N+5	OFFSET FOR DATA TYPE #N								LSB
2N+6									MSB

See Table 17, page 99 for a description of the fields.

Figure 26. Binary Header Data Format

NOTE. This data is always output in this format.

Header information is the first item sent by the Channel Master to the output buffer. The Channel Master always sends the Least Significant Byte (LSB) first.

Table 17: Header Data Format

Hex Digit	Binary Byte	Field	Description
1,2	1	HDR ID / Header ID	Stores the header identification byte (7Fh).
3,4	2	HDR ID / Data Source ID	Stores the data source identification byte (7Fh for the Channel Master).
5-8	3,4	Bytes / Number of bytes in ensemble	This field contains the number of bytes from the start of the current ensemble up to, but not including, the 2-byte checksum (Figure 34, page 123).
9,10	5	Spare	Undefined.
11,12	6	No. DT / Number of Data Types	This field contains the number of data types selected for collection. By default, fixed/variable leader, velocity, correlation magnitude, echo intensity, and percent good are selected for collection. This field will therefore have a value of six (4 data types + 2 for the Fixed/Variable Leader data).
13-16	7,8	Address Offset for Data Type #1 / Offset for Data Type #1	This field contains the internal memory address offset where the Channel Master will store information for data type #1 (with this firmware, always the Fixed Leader). Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).
17-20	9,10	Address Offset for Data Type #2 / Offset for Data Type #2	This field contains the internal memory address offset where the Channel Master will store information for data type #2 (with this firmware, always the Variable Leader). Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #2 begins (the first byte of the ensemble is Binary Byte #1).
21-24 thru 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Address Offsets for Data Types #3-n / Offset for Data Type #3 through #n	These fields contain internal memory address offset where the Channel Master will store information for data type #3 through data type #n. Adding “1” to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

11.2 Fixed Leader Data Format

	BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0	
1	FIXED LEADER ID = 0000								LSB 00h
2									MSB 00h
3	CPU F/W VER.								
4	CPU F/W REV.								
5	SYSTEM CONFIGURATION								LSB
6									MSB
7	RESERVED								
8									
9	NUMBER OF BEAMS								
10	NUMBER OF CELLS {WN}								
11	PINGS PER ENSEMBLE {WP}								LSB
12									MSB
13	RANGE CELL LENGTH {WS}								LSB
14									MSB
15	BLANK AFTER TRANSMIT {WF}								LSB
16									MSB
17	RESERVED								
18	LOW CORR THRESH {WC}								
19	NO. CODE REPS								
20	RESERVED								
21	ERROR VELOCITY MAXIMUM {WE}								LSB
22									MSB
23	TPP MINUTES								
24	TPP SECONDS								
25	TPP HUNDREDTHS {TP}								
26	COORDINATE TRANSFORM {EX}								
27	RESERVED								
28									

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29 30	RESERVED	
31	SENSOR SOURCE {EZ}	
32	SENSORS AVAILABLE	
33 34	BIN 1 DISTANCE	
35 36 37 38	RESERVED	
39	FALSE TARGET THRESH {WA}	
40	RESERVED	
41 42	TRANSMIT LAG DISTANCE	LSB MSB
43 ↓ 50	CPU BOARD SERIAL NUMBER	LSB ↓ MSB
51	SYSTEM BANDWIDTH {WB}	LSB
52 53 54	RESERVED	MSB
55 ↓ 58	CHANNEL MASTER SERIAL NUMBER	

See Table 18, page 102 for a description of the fields

Figure 27. Fixed Leader Data Format

NOTE. This data is always output in this format.

Fixed Leader data refers to the non-dynamic Channel Master data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The Channel Master always sends Fixed Leader data as output data (LSBs first).

Table 18: Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word 0000 (00 00h). LSB is sent first.
5,6	3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
7,8	4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
9-12	5,6	Sys Cfg / System Configuration	This field defines the Channel Master hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. LSB BITS 7 6 5 4 3 2 1 0 - - - - - 0 0 0 75-kHz SYSTEM - - - - - 0 0 1 150-kHz SYSTEM - - - - - 0 1 0 300-kHz SYSTEM - - - - - 0 1 1 600-kHz SYSTEM - - - - - 1 0 0 1200-kHz SYSTEM - - - - - 1 0 1 2400-kHz SYSTEM - - - - - 1 1 0 38-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - RESERVED - - 0 1 - - - - RESERVED - - 1 0 - - - - RESERVED - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 25E BEAM ANGLE 0 0 1 0 - - - - 2-BEAM + VERT. STAGE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).
13 - 16	7-8	Reserved	Reserved
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The Channel Master uses two beams to calculate horizontal velocity and one vertical beam to calculate stage.

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Table 18: Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
19,20	10	WN / Number of Cells	Contains the number of range cells over which the Channel Master collects data (WN-command). Scaling: LSD = 1 range cell; Range = 1 to 128 range cells
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the Channel Master does not collect the WD water-profile data. Note: The Channel Master automatically extends the ensemble interval (TE) if the product of WP and time per ping (TP) is greater than TE (i.e., if WP x TP > TE). Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
25-28	13,14	WS / Range cell Length	Contains the length of one range cell (WS-command). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the Channel Master to allow the transmit circuits time to recover before the receive cycle begins (WF-command). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Reserved	Reserved
35,36	18	WC / Low Corr Thresh	Contains the minimum threshold of correlation that water-profile data can have to be considered good data (WC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	Reserved	Reserved
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the Channel Master flags all four beams of the affected bin as bad. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
45,46	23	Minutes	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The Channel Master automatically extends the ensemble interval (set by TE) if (WP x TP > TE).
47,48	24	Seconds	
49,50	25	Hundredths	

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the Channel Master collected data.
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = RESERVED`
			`xxx11xxx = RESERVED`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN TRANSFORMATION`
			`xxxxxx1x = RESERVED`
			`xxxxxxx1 = BIN MAPPING USED`

53-60	27-30	Reserved	Reserved

Table 18: Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following. FIELD DESCRIPTION 1xxxxxx = CALCULATES EC (SPEED OF SOUND) FROM ED, ES, AND ET x1xxxxx = USES ED FROM DEPTH SENSOR xx1xxxx = USES EH FROM TRANSDUCER HEADING SENSOR xxx1xxx = USES EP FROM TRANSDUCER PITCH SENSOR xxxx1xx = USES ER FROM TRANSDUCER ROLL SENSOR xxxxx1x = USES ES (SALINITY) FROM CONDUCTIVITY SENSOR xxxxxx1 = USES ET FROM TRANSDUCER TEMPERATURE SENSOR NOTE: If the field = 0, or if the sensor is not available, the Channel Master uses the manual command setting. If the field = 1, the Channel Master uses the reading from the internal sensor.
63,64	32	Sensor Avail	This field reflects which sensors are available. The bit pattern is the same as listed for the EZ-command (above).
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first range cell (bin). This distance is a function of range cell length (WS), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-76	35-38	Reserved	Reserved
77,78	39	WA / False Target Threshold	Contains the threshold value used to reject data received from a false target, usually fish (WA-command). Scaling: LSD = 1 count; Range = 0 to 255 counts (255 disables)
79,80	40	Reserved	Reserved
81-84	41,42	LagD / Transmit lag distance	This field contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters
85-100	43-50	CPU Board Serial Number	Contains the serial number of the CPU board.
101-102	51	WB / System Bandwidth	Contains the WB-command setting. Range = 0 to 1
103-108	52-54	Reserved	Reserved.
109-116	55-58	Serial #	Channel Master serial number.

11.3 Variable Leader Data Format

	BIT POSITIONS								
BYTE	7	6	5	4	3	2	1	0	
1	VARIABLE LEADER ID = 0080								LSB 80h
2									MSB 00h
3	ENSEMBLE NUMBER								LSB
4									MSB
5	RTC YEAR {TS}								
6	RTC MONTH {TS}								
7	RTC DAY {TS}								
8	RTC HOUR {TS}								
9	RTC MINUTE {TS}								
10	RTC SECOND {TS}								
11	RTC HUNDREDTHS {TS}								
12	ENSEMBLE # MSB								
13	BIT RESULT								LSB
14									MSB
15	SPEED OF SOUND {EC}								LSB
16									MSB
17	DEPTH OF TRANSDUCER {ED}								LSB
18									MSB
19	RESERVED								LSB
20									MSB
21	PITCH								LSB
22									MSB
23	ROLL								LSB
24									MSB
25	SALINITY {ES}								LSB
26									MSB
27	TEMPERATURE {ET}								LSB
28									MSB
29	MPT MINUTES								
30	MPT SECONDS								
31	MPT HUNDREDTHS								
32	RESERVED								
33	PITCH STD								
34	ROLL STD								

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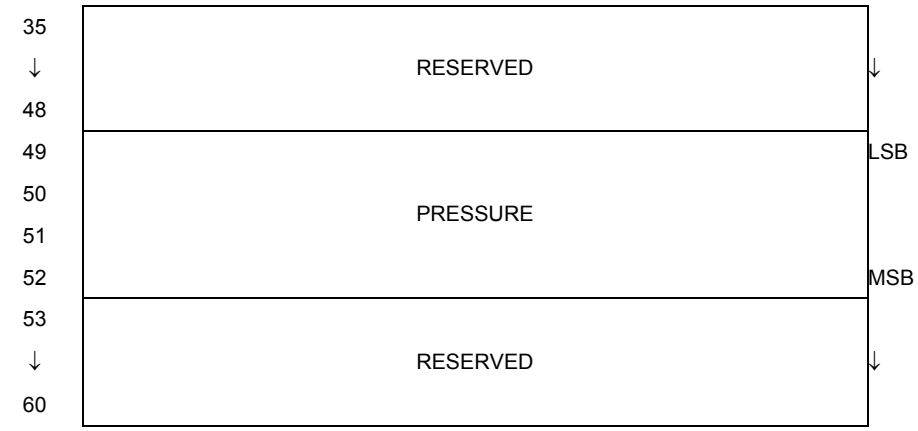

See Table 19, page 107 for a description of the fields.

Figure 28. Variable Leader Data Format

NOTE. This data is always output in this format.

Variable Leader data refers to the dynamic Channel Master data (from clocks/sensors) that change with each ping. The Channel Master always sends Variable Leader data as output data (LSBs first).

Table 19: Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VID / Variable Leader ID	Stores the Variable Leader identification word 0080 (80 00h). LSB is sent first.

5-8	3,4	Ens / Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply.
			Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles
			NOTE: The first ensemble collected is #1. At "rollover," we have the following sequence:
			`1 = ENSEMBLE NUMBER 1`
			`  ↓`
			`65535 = ENSEMBLE NUMBER 65,535 | ENSEMBLE`
			`    0 = ENSEMBLE NUMBER 65,536 | #MSB FIELD`
			`    1 = ENSEMBLE NUMBER 65,537 | (BYTE 12)`
			`INCR.`

9,10	5	RTC Year	These fields contain the time from the Channel Master's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The Channel Master does account for leap years.
11,12	6	RTC Month	
13,14	7	RTC Day	
15,16	8	RTC Hour	
17,18	9	RTC Minute	
19,22	10	RTC Second	
21,22	11	RTC Hundredths	
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) "rolls over." This allows ensembles up to 16,777,215. See Ensemble Number field above.

25-28	13,14	BIT / BIT Result	This field contains the results of the Channel Master's Built-in Test function. A zero code indicates a successful BIT result.
			`MSB BYTE 14  LSB BYTE 13`
			`76543210  76543210`
			`xxxxxxxx  xxxxxxx1 = transmitter shutdown`
			`xxxxxxxx  xxxxxx1x = transmitter over current`
			`xxxxxxxx  xxxxx1xx = transmitter under current`
			`xxxxxxxx  xxxx1xxx = transmitter under voltage`
			`xxxxxxxx  xxx1xxxx = FIFO interrupt missed`
			`xxxxxxxx  xx1xxxxx = FIFO ISR Re-entry`
			`xxxxxxx1  xxxxxxxx = Sensor module failure`
			`xxxxxx1x  xxxxxxxx = Watchdog disabled`

29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s

Continued next page

Table 19: Variable Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters -1 = Unknown (Hex FFFF)
37-40	19- 20	Reserved	Reserved
41-44	21-22	Pitch	For pitch, roll, and temperature, a value of –32768 indicates no measurement (Hex 8000).
45-48	23-24	Roll	
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt -1 = Unknown (Hex FFFF)
53-56	27,28	ET / Tempera-ture	Contains the temperature of the water at the transducer head (ET-command). This value may be a manual setting or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 de-grees C.
57,58	29	MPT minutes	This field contains the Minimum Pre-Ping Wait Time between ping groups in the ensemble.
59,60	30	MPT seconds	
61,62	31	MPT hundredths	
63 - 64	32	Reserved	Reserved
65-66	33	Pitch STD	Pitch standard deviation. Scaling: LSB = 0.1 degree
67-68	34	Roll STD	Roll standard deviation. Scaling: LSB = 0.1 degree
69-96	35 -48	Reserved	Reserved
97-104	49-52	Pressure	Contains the pressure of the water at the transducer head relative to one atmosphere (sea level). Output is in deca-pascals. Scaling: LSD=1 deca-pascal; Range = -2,147,483,648 to +2,147,483,648 deca-pascals. Output is -2,147,483,648 when pressure is invalid.
105-120	53-60	Reserved	Reserved

11.4 Velocity Data Format

BYTE	BIT POSITIONS 7/S	6	5	4	3	2	1	0	
1	VELOCITY ID = 0100								LSB 00h
2									MSB 01h
3	RANGE CELL #1, VELOCITY 1								LSB
4									MSB
5	RANGE CELL #1, VELOCITY 2								LSB
6									MSB
7	RESERVED								
8									
9									
10									
11	RANGE CELL #2, VELOCITY 1								LSB
12									MSB
13	RANGE CELL #2, VELOCITY 2								LSB
14									MSB
15	RESERVED								
16									
17									
18									
↓	(SEQUENCE CONTINUES FOR UP TO 255 CELLS)								↓
1019	RANGE CELL #255, VELOCITY 1								LSB
1020									MSB
1021	RANGE CELL #255, VELOCITY 2								LSB
1022									MSB
1023	RESERVED								
1024									
1025									
1026									

See Table 20, page 110 for description of fields

Figure 29. Velocity Data Format

NOTE. The number of range cells is set by the WN-command.

The Channel Master packs velocity data for each range cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The Channel Master scales velocity data in millimeters per second (mm/s). A value of –32768 (8000h) indicates bad velocity values. All velocities are relative based on a stationary instrument.

The setting of the EX-command (Coordinate Transformation) determines how the Channel Master references the velocity data as shown below.

EX-CMD	COORD SYS	VEL 1	VEL 2
xxx00xxx	BEAM	TO BEAM 1	TO BEAM 2
xxx01xxx	INST	Bm2-Bm1	FROM TRANSDUCER
POSITIVE VALUES INDICATE WATER MOVEMENT			

Table 20: Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word 0100 (00 01h). LSB is sent first.
5-8	3,4	Range cell 1, Velocity 1	Stores velocity data for range cell #1, velocity 1. See above.
9-12	5,6	Range cell 1, Velocity 2	Stores velocity data for range cell #1, velocity 2. See above.
13-16	7,8	Reserved	Reserved
17-20	9,10	Reserved	Reserved
21-2052	11-1026	Cells 2 – 255 (if used)	These fields store the velocity data for range cells 2 through 255 (depending on the setting of the WN-command). These fields follow the same format as listed above for range cell 1.

11.5 Correlation Magnitude, Echo Intensity, Percent-Good Data, and Status Format

BIT POSITIONS

BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB 00h
2	Correlation Magnitude = 0200, Echo Intensity = 0300, Echo Intensity = 0400, Status = 0500								MSB 02 – 05h
3	RANGE CELL #1, FIELD #1								
4	RANGE CELL #1, FIELD #2								
5	RESERVED								
6									
7	RANGE CELL #2, FIELD #1								
8	RANGE CELL #2, FIELD #2								
9	RESERVED								
10									
↓	(SEQUENCE CONTINUES FOR UP TO 255 BINS)								↓
511	RANGE CELL #255, FIELD #1								
512	RANGE CELL #255, FIELD #2								
513	RESERVED								
514									

See Table 21, page 112 through Table 24, page 114 for a description of the fields.

Figure 30. Binary Correlation Magnitude, Echo Intensity, Percent-Good Data, and Status Format

NOTE. The number of range cells is set by the WN-command.

Correlation magnitude data give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The Channel Master represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target). A value of zero indicates bad correlation values.

Table 21: Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word 0200 (00 02h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores correlation magnitude data for range cell #1, beam #1. See above.
7,8	4	Range cell 1, Field 2	Stores correlation magnitude data for range cell #1, beam #2. See above.
9,10	5	Reserved	Reserved
11,12	6	Reserved	Reserved
13 – 1028	7 – 514	Cells 2 – 255 (if used)	These fields store correlation magnitude data for range cells 2 through 255 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range cell 1.

The echo intensity scale factor is about 0.45 dB per Channel Master count. The Channel Master does not directly check for the validity of echo intensity data.

Table 22: Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1 – 4	1,2	ID Code	Stores the echo intensity data identification word 0300 (00 03h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores echo intensity data for range cell #1, beam #1. See above.
7,8	4	Range cell 1, Field 2	Stores echo intensity data for range cell #1, beam #2. See above.
9,10	5	Reserved	Reserved
11,12	6	Reserved	Reserved
13 – 1028	7 – 514	Cells 2 – 255 (if used)	These fields store echo intensity data for range cells 2 through 255 (depending on the WN-command) for all beams. These fields follow the same format as listed above for range cell 1.

The percent-good data field is a data-quality indicator that reports the percentage (0 to 100) of good data collected for each range cell of the velocity profile. The setting of the EX-command (Coordinate Transformation) determines how the Channel Master references percent-good data as shown below.

EX-Command	Coord. Sys	Velocity 1	Velocity 2	Velocity 3	Velocity 4
			Percentage Of Good Pings For:		
xxx00xxx	Beam	Beam 1	BEAM 2	RESERVED	RESERVED
			Percentage Of:		
xxx01xxx	Inst	Partial Solution Transformation (note 1)	Transformations Rejected (note 2)	No Solution Available in Bin	Full Solution Transformations

1. Because profile data did not exceed correlation threshold (WC).
2. Because the error velocity threshold (WE) was exceeded.

At the start of the velocity profile, the backscatter echo strength is typically high on both beams. Under this condition, the Channel Master uses both beams to calculate the orthogonal and error velocities. As the echo returns from far away range cells, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the Channel Master to reject some of its range cell data. This causes the Channel Master to stop calculating velocities. As an example, let us assume range cell 60 has returned the following percent-good data.

```
FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 0, FIELD #4 = 0
```

If the EX-command was set to collect velocities in BEAM coordinates, the example values show the percentage of pings having good solutions in cell 60 for each beam based on the Low Correlation Threshold (WC-command). Here, beam 1=50% and beam 2=5%. These are <u>not</u> typical nor desired percentages. Typically, you would want both beams to be about equal and greater than 25%.

On the other hand, if velocities were collected in INSTRUMENT coordinates and bin 60 returned the following percent-good, the results would be interpreted differently.

```
FIELD #1 = 50, FIELD #2 = 5, FIELD #3 = 45, FIELD #4 = 0
```

<u>FIELD 1 - Percentage of Partial Solutions</u> - Shows percentage of successful velocity calculations (50%) resulting in Partial Solutions. A Partial Solution is a solution that does not result in an error velocity. This occurs because there is not enough information to compute the error velocity.

<u>FIELD 2 - Percentage of transformations rejected</u> - Shows percent of error velocity (5%) that was less than the WE-command setting. The WE com-

mand has a default of 5000 mm/s. This large WE setting effectively prevents the Channel Master from rejecting data based on error velocity.

FIELD 3 - Percentage of No Solution Transformations - 45% of the velocity data were rejected because there was insufficient information (velocity Data) to attempt a transformation.

FIELD 4 - Percentage of Full Solutions - 0% of the velocity data collected during the ensemble for range cell 60 generated a Full Solution. A Full Solution indicates that an error velocity is available. The Channel Master is not capable of generating Full Solutions because 2-beams do not provide sufficient information to generate a Full Solution.

Table 23: Percent-Good Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word 0400 (00 04h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores percent-good data for range cell #1, field 1. See above.
7,8	4	Range cell 1, Field 2	Stores percent-good data for range cell #1, field 2. See above.
9,10	5	Range cell 1, Field 3	Stores percent-good data for range cell #1, field 3. See above.
11,12	6	Range cell 1, Field 4	Stores percent-good data for range cell #1, field 4. See above.
13-1028	7-514	Range cell 2 – 255 (if used)	These fields store percent-good data for range cells 2 through 255 (depending on the WN-command), following the same format as listed above for range cell 1.

These fields contain information about the status and quality of the ADCP data. A value of 0 means the measurement was good. A value of 1 means the measurement was bad.

Table 24: Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the percent-good data identification word 0500 (00 04h). LSB is sent first.
5,6	3	Range cell 1, Field 1	Stores status data for range cell #1, field 1. See above.
7,8	4	Range cell 1, Field 2	Stores status data for range cell #1, field 2. See above.
9,10	5	Range cell 1, Field 3	Stores status data for range cell #1, field 3. See above.
11,12	6	Range cell 1, Field 4	Stores status data for range cell #1, field 4. See above.
13-1028	7-514	Range cell 2 – 255 (if used)	These fields store status data for range cells 2 through 255 (depending on the WN-command), following the same format as listed above for range cell 1.

11.6 Firmware Version Data Format

The firmware version field is a short section of ASCII text in the middle of the binary ensemble data. It contains the version numbers of all the firmware in the Channel Master. The same version numbers are listed by the PS0 command (see "PS0 – System Configuration," page 77).

Version numbers in the field are separated by line feed characters (0Ah). The text section is terminated with a NUL character (00h). The length of this field is determined by the number of characters in each version number, and the number of firmware modules. Given Teledyne RDI's version number formats, this field should be either 39 or 50 bytes long with release version firmware. Table 25 illustrates the format for release firmware with an SDI-12 personality module present. If there is no SDI-12 personality module, the SDI-12 firmware versions and their line feeds will not be present.

Table 25: Firmware Version Data Format

Binary Byte	Field	Description
1,2	Firmware ID	Stores the Variable Leader identification word 0002 (02 00h). LSB is sent first.
3	Line Feed	0Ah
4-11	Product Version	Product Version number plus line feed. When any firmware changes version, the new set of the latest firmware modules are assigned a new product version.
12-17	CPU Firmware	Firmware version number for the main CPU plus line feed.
18-26	FPGA Firmware	Low level firmware version number for the main CPU plus line feed.
27-32	Sensor Boot	Low level firmware version number for the sensor board processor plus line feed.
33-38	Sensor Firmware	Firmware version number for the sensor board processor plus line feed.
39-44	SDI-12 Boot	Low level firmware version number for the SDI-12 personality module plus line feed.
45-49	SDI-12 Firmware	Firmware version number for the SDI-12 personality module plus line feed.
50	Terminal NUL	00h

NOTE. Turning off the Status bit on the WD command (see "WD – Data Out," page 92) will disable the output of the Firmware Version Data Format.

11.7 Surface Track Status Output

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	Vertical Beam Status ID = 4000								LSB 00h
2									MSB 40h
3	Depth (Corrected Surface Track)								
4									
5									
6									
7	Depth (Uncorrected Surface Track)								
8									
9									
10									
11	Evaluation Amplitude								
12	Amplitude at the Surface								
13	%Good of Surface Track								
14	STD Surface Track								
15									
16									
17									
18	Min Surface Track								
19									
20									
21									
22	Max Surface Track								
23									
24									
25									
26	Pressure Depth Correction								
27									
28									
29									
30	Depth (Uncorrected Pressure)								
31									
32									
33									
34	Percent Good of Depth based on Pressure								

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BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0
35 36 37 38	STD of Depth based on Corrected Pressure							
39 40 41 42	Min of Depth based on Corrected Pressure							
43 44 45 46	Max of Depth based on Corrected Pressure							

Figure 31. Surface Track Status Output

For Evaluation Amplitude, Amplitude at the Surface, Standard Deviation, Max Surface Track and Min Surface Track the following applies: If number of bursts per ensemble is 1, then this is based on the good pings in the ensemble. If the number of bursts per ensemble is greater than 1, then this is based on the output from each burst which could be from individual pings or from average RSSI data.

Table 26: Surface Track Status Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_STATUS_ID / Vertical Beam Status ID	Stores the Vertical Beam Status ID word 4000 (00 40h). LSB is sent first.
5-12	3-6	Depth (Corrected Surface Track)	Depth based on surface track output with corrections applied. Units: 0.1mm
13-20	7-10	Depth (Uncorrected Surface Track)	Depth based on raw surface track output. Units: 0.1mm
21,22	11	Evaluation Amplitude	Maximum detection filter evaluation amplitude. Units: Counts
23,24	12	Amplitude at the Surface	Signal amplitude at Surface. Units: Counts
25,26	13	%Good of Surface Track	Percentage of surface track pings in an ensemble burst that are marked good based on signal strength and a comparison with burst average depth (see VC command). Units: %
27-34	14-17	STD Surface Track	Standard deviation of good depths from corrected surface track pings. Units: 0.1mm
35-42	18-21	Min Surface Track	Minimum depth of good corrected surface track. Units: 0.1mm pings
43-50	22-25	Max Surface Track	Maximum depth of good corrected surface track pings Units: 0.1mm
51-58	26-29	Pressure Depth Correction	Last good difference between pressure depth and vertical beam depth ensemble outputs. Units: 0.1mm
59-66	30-33	Depth (Uncorrected Pressure)	Depth based on raw pressure output. Units: 0.1mm
67,68	34	%Good of Depth based on Pressure	Percentage of corrected pressure measurements good in the ensemble. Units: %
69-76	35-38	STD of Depth based on Corrected Pressure	Standard deviation of good depths based on corrected pressure measurements in the ensemble. Units: 0.1mm
77-84	39-42	Min of Depth based on Corrected Pressure	Minimum depth of corrected pressure measurements in the ensemble. Units: 0.1mm
85-92	43-46	Max of Depth based on Corrected Pressure	Maximum depth of corrected pressure measurements in the ensemble. Units: 0.1mm

11.8 Surface Track Amplitude Output

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	Vertical Beam Amp ID = 4002								LSB 02h
2									MSB 40h
3	Pings in Burst (NPing)								
4	Bin Location of Surface (Avg.)								
5									
6	Filter Evaluation Amp (Avg.)								
7	Amplitude at Surface (Avg.)								
8	W Filter Bin Location of Surface (Avg.)								
9									
10	W Filter Evaluation Amp (Avg.)								
11	W Filter Amplitude at Surface (Avg.)								
12	Leading Edge Filter Bin Location of Surface (Avg.)								
13									
14	Leading Edge Filter Evaluation Amp (Avg.)								
15	Leading Edge Amplitude at Surface (Avg.)								
16 to 16+2*NPing-1	W Filter Bin Location (Individual Pings)								
16+2*NPing to 16+5*NPing-1	W Filter Evaluation Amplitude (Individual Pings)								
16+5*NPing to 16+6*NPing-1	W Filter Amplitude (Individual Pings)								
16+6*NPing to 16+7*NPing-1	Status of Individual Pings								

Figure 32. Surface Track Amplitude Output

The data in this structure is from the last burst in an ensemble.

Table 27: Surface Track Amplitude Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_AMP_ID / Vertical Beam Amp ID	Stores the Vertical Beam Amplitude ID word 4002 (02 40h). LSB is sent first.
5,6	3	Pings in Burst (NPing)	Number of surface track pings in an ensemble burst
7-10	4,5	Bin Location of Surface (Avg)	Final bin location of the surface based on either averaged RSSI data or averages of detected bin locations from single pings. Units: Samples
11,12	6	Filter Evaluation Amp (Avg)	Final filter evaluation amplitude based on either averaged RSSI data or averages of evaluation amplitudes from single pings. Units: Counts
13,14	7	Amplitude at Surface (Avg)	Final amplitude based on either averaged RSSI data or averages of amplitudes from single pings. Units: Counts
15-18	8,9	W Filter Bin Location of Surface (Avg)	W filter bin location of the surface from averaged RSSI data. Units: Samples
19,20	10	W Filter Evaluation Amp (Avg)	Evaluation amplitude output of the W Filter where the filter detects the surface using averaged RSSI data. Units: Counts
21,22	11	W Filter Amplitude at Surface (Avg)	RSSI amplitude at the bin location where the W filter detects the surface using averaged RSSI data. Units: Counts
23-26	12,13	Leading Edge Filter Bin Location of Surface (Avg)	Leading edge filter bin location of the surface from averaged RSSI data. Units: Samples
27,28	14	Leading Edge Filter Evaluation Amp (Avg)	Evaluation amplitude output of the leading edge filter where the filter detects the surface using averaged RSSI data. Units: Counts
29,30	15	Leading Edge Amplitude at Surface (Avg)	Leading edge amplitude at the bin location where the Filter detects the surface using averaged RSSI data. Units: Counts
31 to 31+4*NPing	16 to 16+2*NPing-1	W Filter Bin Location (Individual Pings)	W filter bin location where the filter detects the surface for individual pings in the ensemble burst. Units: Samples
31+4*NPing+1 to 31+6*NPing	16+2*NPing to 16+5*NPing-1	W Filter Evaluation Amplitude (Individual Pings)	W filter evaluation amplitude where the filter detects the surface for individual pings in the ensemble burst. Units: Counts
31+6*NPing-1 to 31+8*NPing	16+5*NPing to 16+6*NPing-1	W Filter Amplitude (Individual Pings)	W filter amplitude where the filter detects the surface for individual pings in the ensemble burst.
31+8*NPing-1 to 31+10*NPing	16+6*NPing to 16+7*NPing-1	Status of Individual Pings	Final status of each ping after data quality checks.

11.9 Surface Track Commands Output

BYTE	BIT POSITIONS 7	6	5	4	3	2	1	0	
1	Vertical Beam Commands ID = 4001								LSB 01h
2									MSB 40h
3	VM_Blank								
4									
5	VM_Pings								
6									
7	VM_BW								
8	VM_DetectMode								
9	VM_PressScreen								
10	VM_RangeScreen								
11	VM_EdgeDetectThres								
12	VM_EdgeDetectDelta								
13									
14	VM_RcvrGain								
15	VM_OffsetTenthsMM								
16									
17	VM_ScalePPM								
18									
19	VM_MaxRange								
20									
21	VM_MaxRange								
22									
23	VM_XmtLength								
24									
25	VM_WThreshold								
26	VM_WWidth								
27									
28	VM_XmitPwr								

Table 28: Surface Track Commands Output

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VB_CMD_ID / Vertical Beam Commands ID	Stores the Vertical Beam Commands ID word 4001 (01 40h). LSB is sent first.
5-8	3,4	VM_Blank	See VF command (see "VF – Vertical Beam Blank after Transmit," page 88).
9-12	5,6	VM_Pings	See VP command (see "VP – Vertical Beam Number of Pings per Ensemble," page 88).
13,14	7	VM_BW	See #VB command.
15,16	8	VM_DetectMode	See #VC command (see "Expert Level Vertical Beam Command Descriptions," page 89).
17,18	9	VM_PressScreen	
19,20	10	VM_RangeScreen	
21,22	11	VM_EdgeDetectThres	See #VE command.
23-26	12,13	VM_EdgeDetectDelta	See #VE command.
27,28	14	VM_RcvrGain	See #VJ command.
29-32	15,16	VM_OffsetTenthsMM	See #VO command.
33-36	17,18	VM_ScalePPM	See #VO command.
27-40	19,20	VM_MaxRange	See #VR command.
41-44	21,22	VM_SubPings	See #VS command.
45-48	23,24	VM_XmtLength	See #VT command.
49,50	25	VM_WThreshold	See #VW command.
51-54	26,27	VM_WWidth	See #VW command.
55,56	28	VM_XmitPwr	See #VX command.

NOTE. For information on other expert level vertical beam commands, see FST-006 (available for download on www.rdinstruments.com) or contact Teledyne RDI (see "Technical Support," page 137).

11.10 Binary Reserved BIT Data Format

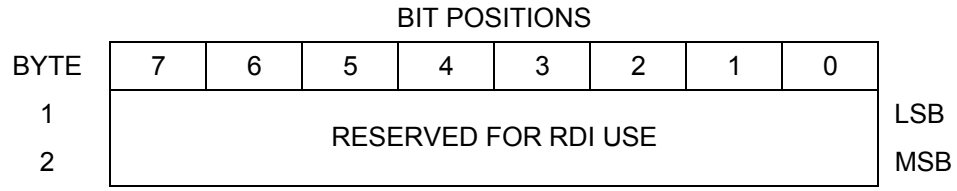


Figure 33. Binary Reserved BIT Data Format

NOTE. The data is always output in this format. See Table 29 for a description of the fields.

Table 29: Reserved for RDI Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Reserved for RDI's use	This field is for RDI (internal use only).

11.11 Binary Checksum Data Format

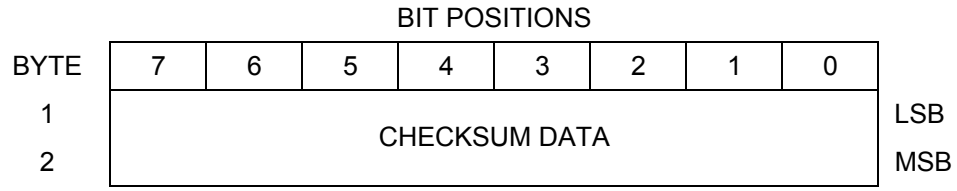


Figure 34. Binary Checksum Data Format

NOTE. The data is always output in this format. See Table 30 for a description of the fields.

Table 30: Checksum Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65535 checksum. The Channel Master computes the checksum by summing all the bytes in the output buffer excluding the checksum.

12 Channel Master PD14 Output Data Format

This section details the specification of an output format for data consisting of a header (with timestamp), a two dimensional profile of velocity, acoustic intensity, and standard error data, tilt sensor data, stage data, and a checksum. This format is primarily intended for integrating the Channel Master with other systems or data loggers. Data will be output in this format when PD14 is selected as the output format.

12.1 Format

Table 31, page 125 below summarizes the PD14 format. The number of bytes in the ensemble, not including the checksum is reported in the NBytes field and is equal to 10 * NBins + 23 bytes, where NBins is the number of range cells in the profile. The NEnsemble field shows the number of ensembles since the start of a deployment and provides for tracking sequences of ensembles and distinguishing one ensemble from another. Tilts are reported as signed quantities in the interval –180.00 to +180.00 degrees. Stage measurements are reported as unsigned quantities in units of $1/10^{th}$ mm. Velocities are reported as signed quantities in mm/sec. Acoustic intensities are reported in unsigned units of counts. Standard error will be reported as unsigned quantities in mm/sec. The checksum will be calculated as described by the CRC-16 algorithm using the polynomial $x^{16}+x^{15}+x^2+1$ with an initial register value of 0xFFFF.

12.2 Invalid Data

Several quantities may on occasion be out of range or may not pass quality checks. In such cases, an invalid result will be indicated. For tilts, an invalid result will be indicated by a value of –327.68 degrees. Invalid velocities are indicated by a value of –32768 mm/s. Invalid standard error will be indicated by a value of 65535 (all bits set). Invalid stage measurements are indicated by a value of 42949.67295 meters (all bits set). No provision will be made for any other invalid quantities in this format.

Table 31: Channel Master PD14 Output Data Format

Position	Size	Name	Description
0	2	SOE	Start of ensemble - always 0x8F8F
2	2	NBytes	Number of bytes
4	2	NEnsemble	Number of ensembles since start of deployment
6	2	Year	4-digit year
8	1	Month	Month
9	1	Day	Day of month
10	1	Hour	Hour of day since midnight
11	1	Minutes	Number of minutes since the last hour
12	1	Seconds	Number of seconds since the last minute
13	1	Hundredths	Hundredths of a second since the last second
14	2	Tilt 1	Tilt 1 measurement in 1/100th degree
16	2	Tilt 2	Tilt 2 measurement in 1/100th degree
18	4	Vertical	Vertical stage measurement in 1/10th millimeter
22	1	NBins	Number of profile bins
23	2	X1	X component of velocity for bin 1
25	2	Y1	Y component of velocity for bin 1
-	-	-	-
4*n*+19	2	X*n*	X component of velocity for bin *n*
4*n*+21	2	Y*n*	Y component of velocity for bin *n*
4*N*+23	1	I11	Beam 1 intensity for bin 1 (NBins = *N*)
4*N*+24	1	I21	Beam 2 intensity for bin 1 (NBins = *N*)
-	-	-	-
4*N*+2*m*+21	1	I1*m*	Beam 1 intensity for bin *m* (NBins = *N*)
4*N*+2*m*+22	1	I2*m*	Beam 2 intensity for bin *m* (NBins = *N*)
6*N*+23	2	SX1	Standard error of X component of velocity for bin 1 (NBins = *N*)
6*N*+25	2	SY1	Standard error of Y component of velocity for bin 1 (NBins = *N*)
-	-	-	-
6*N*+4*m*+19	2	SX*m*	Standard error of X component of velocity for bin *m* (NBins = *N*)
6*N*+4*m*+21	2	SY*m*	Standard error of Y component of velocity for bin *m* (NBins = *N*)
10*N*+23	2	Checksum	CRC-16

13 Channel Master PD19 Output Data Format

PD19 output data format outputs ASCII data on the serial port and records PD0 data internally, if recording is enabled. The output of PD19 is a comma delimited format similar to a NEMA format. A typical output would appear as:

```
PRDIQ, 12, 432456.123, 2.45, 234.45, 0.65, 345.33, 15.12, 2.56, -0.32, 0
```

In order from left to right, the fields are described in Table 32.

Table 32: PD19 Output Data Format

Field	Description
Header	"PRDIQ" which is the unique identifier that the following data is in PD19 ASCII format
High Volume	The first numeric field is always an integer which represents the millions portion of accumulated volume.
Low Volume	The second data field is the lower part of the total volume. So, in the above output, the total volume is 12432456.123. The volume has been split into two separate fields because many devices like RTUs or PLCs can only accept values up to 999999.999 in a single field.
Stage	The total of the Channel Master elevation (from the IE command) and the range to the surface from the vertical acoustic beam.
Flow rate	The computed flow using the mean velocity and area computed from the channel geometry.
Mean velocity	The average x-component velocity of the cells selected with IS multiplied by the rating from the coefficients from the IV command.
Area	Area computed from stage and the channel geometry.
Temperature	Temperature from the internal sensors of the Channel Master
Pitch	Pitch from the internal sensors of the Channel Master
Roll	Roll from the internal sensors of the Channel Master
Fault Count	The number of successive readings for which either vertical range to surface or more than 50% of velocity cells are no valid. This will count up to the value set in IF. Until this value is reached, the last good velocity or stage data will be used to compute the other quantities.

NOTE. The SDI-12 output now includes pitch, roll, and mean rated velocity (the same as PD19), as additional fields of the output available following the M! command. The SDI-12 command aM9! (where "a" is the Channel Master SDI-12 address) will output, mean rated velocity, stage, area, flow, high volume, and low volume in the same units and with the same scaling as the output using PD-19.

14 How to Decode a Channel Master Ensemble

Use the following information to help you write your own software.

14.1 Rules for the Channel Master Data Format PD0

a. All data types (i.e. fixed leader, variable leader, velocity, echo intensity, correlation, percent good, etc.) will be given a specific and unique ID number. The table below shows some of the most common IDs.

Table 33: Common Data Format IDs

ID	Description
0x7F7F	Header
0x0000	Fixed Leader
0x0080	Variable Leader
0x0100	Velocity Profile Data
0x0200	Correlation Profile Data
0x0300	Echo Intensity Profile Data
0x0400	Percent Good Profile Data
0x0500	Status Profile Data
0x4000	Surface Track Status
0x4001	Surface Track Commands
0x4002	Surface Track Amplitude

b. Once a data type has been given an ID number and the format of that data has been published we consider the format for each field has being fixed. Fixed refers to units used for a given field, the number of bytes in a given field, and the order in which the fields appear within the data type. Fixed does not refer to the total number of bytes in the data type - see Rule “c”.

c. Data may be added to an existing data type only by adding the bytes to the end of the data format. As an example, the variable leader data contains information on ensemble number, time, heading, pitch, roll, temperature, pressure, etc. The format for the bytes 1-65 are now specified by changes added in support to the Channel Master ADCP. If additional sensor data is to be added to the variable leader data then it must be added to the end of the data string (bytes 66-x as an example).

d. The order of data types in an ensemble is not fixed. That is there is no guarantee that velocity data will always be output before correlation data.

e. The header data will include the number of data types in the files and the offset to each ID number for each data type.

f. The total number of the bytes in an ensemble minus the 2-byte checksum will be included in the header.

14.2 Recommended Data Decoding Sequence for Data Format PD0

a. Locate the header data by locating the header ID number (in the case of PD0 profile data that will be 7F7F).

b. Confirm that you have the correct header ID by:

   1. Locating the total number of bytes (located in the header data) in the ensemble. This will be your offset to the next ensemble.

   2. Calculate the checksum of total number of bytes in the ensemble excluding the checksum. The checksum is calculated by adding the value of each byte. The 2-byte least significant digits that you calculate will be the checksum.

   3. Read the 2-byte checksum word at the end of the ensemble, located by using the checksum offset in the header (determined in step "b-1") and compare this checksum word to the value calculated in step "b-2".

   4. If the checksums match then you have a valid ensemble. If the checksums do not match then you do not have a valid ensemble and you need to go back to step "a" and search for the next header ID number occurrence.

c. Locate the number of data types (located in the header data).

d. Locate the offset to each data type (located in the header data).

e. Locate the data ID type you wish to decode by using the offset to each data type and confirm the data ID number at that offset matches the ID type you are looking for.

f. Once the proper ID type has been located, use the Channel Master Operation Manual to understand what each byte represents in that particular data type.

14.3 Pseudo-Code for Decoding PD0 Ensemble Data

The following examples show the pseudo-code for decoding PD0 ensemble data.

a. Define structures, which contain all fields in all data types of the PD0 format.

   1. typedef struct { <lists of types and fields> } FixedLeader.

   2. typedef struct { <lists of types and fields> } VariableLeader.

3. typedef struct { <lists of types and fields> } VelocityType
4. and so on for every available type.

b. Clear checksum.

c. Look for PD0 ID 0x7F. Add to checksum.

d. Is next byte a 0x7F? Add to checksum.

e. If no, return to step “b”.

f. Else, read next two bytes to determine offset to checksum. Add two bytes to checksum.

g. Read in X more bytes, where X = offset to checksum - 4. Adding all bytes to checksum.

h. Read in checksum word.

i. Do checksums equal?

j. If no, return to “b”.

k. For each available data type (the header contains the # of data types), go to the offset list in header.

1. Create a pointer to type short to the data type at an offset in the list.
2. Check the Type ID.
3. Create a pointer of appropriate type to that location.
4. Repeat for all available data types.

l. Work with data.

m. Return to “b” for next ensemble.

14.4 Example Code for Decoding Channel Master Ensembles

Here is an example of how to decode a Channel Master ensemble. It is written in “C.”

NOTE. Structures must be “packed”; i.e. Don’t let the compiler add “fill bytes” to align fields on word boundaries.

This is an example of a section of code, not a full executable program.

```
/*************************************************************************/
/* Data ID Words */
/*************************************************************************/

   #define FLdrSelected   0x0000
   #define VLdrSelected   0x0080
   #define VelSelected    0x0100
   #define CorSelected    0x0200
   #define AmpSelected    0x0300
   #define PctSelected    0x0400
   #define SttSelected    0x0500
```

```
/*************************************************************************/
/* structures */
/*************************************************************************/

   typedef unsigned char  uchar;
   typedef unsigned short ushort;
   typedef unsigned long  ulong;

   typedef struct {
      uchar        Minute,
                   Second,
                   Sec100;
   }  TimeType;

   typedef struct {
      uchar        Year,
                   Month,
                   Day,
                   Hour,
                   Minute,
                   Second,
                   Sec100;
   }  DateTimeType;

   typedef struct {
      uchar        Version,
                   Revision;
   }  VersionType;

   typedef struct {
      uchar        ID,
                   DataSource;
      ushort       ChecksumOffset;
      uchar        Spare,
                   NDataTypes;
      ushort       Offset [256];
   }  HeaderType;

   typedef struct {
      ushort       ID;
      VersionType  CPUFirmware;
      ushort       Configuration;
      uchar        reserved1,
                   reserved2,
                   NBeams,
                   NBins;
      ushort       PingsPerEnsemble,
                   BinLength,
                   BlankAfterTransmit;
      uchar        reserved3,
                   PctCorrelationLow,
                   NCodeRepetitions,
                   reserved4;
      ushort       ErrVelocityMax;
      TimeType     TimeBetweenPings;
      uchar        CoordSystemParms;
      ushort        reserved5,
                   reserved6;
      uchar        SensorSource,
                   AvailableSensors;
      ushort       DistanceToBin1Middle,
                   reserved7;
      ushort       reserved8
      uchar        FalseTargetThreshold,
                   reserved9;
      ushort       AmtLagDist;
      uchar        CMSerialNum [8];
      uchar        Bandwidth;
      uchar        reserved10 [3];
      ulong        CMSewrialNum;
   }  FixLeaderType;

   typedef struct {
      ushort       ID,
                   EnsembleNumber;

      DateTimeType RecordingTime;
      uchar        ensemble_msb;
```

```
      ushort       BITResult,
                   SpeedOfSound,
                   Depth,
                   reserved1;
      short        Pitch,
                   Roll;
      ushort       Salinity;
      short        Temperature;
      TimeType     MaxTimeBetweenPings;
      uchar        HeadingStddev,
                   PitchStddev,
                   RollStddev;
      uchar        reserved2 [14];
      ulong        pressure;
      uchar        reserved3 [4];
   }  VarLeaderType;

   typedef struct
   {
     ushort        ID;
     short         Data [256];
   } OneBeamShortType;

   typedef struct
   {
     ushort        ID;
     uchar         Data [256];
   } OneBeamUcharType;

   typedef struct {
      ushort       ID;
      short        Data [1024];
   }  IntStructType;

   typedef struct {
      ushort       ID;
      uchar        Data [1024];
   }  ByteStructType;

/*************************************************************************/
/* Global Pointers */
/*************************************************************************/
   HeaderType       *HdrPtr;
   FixLeaderType    *FLdrPtr;
   VarLeaderType    *VLdrPtr;
   IntStructType    *VelPtr;
   ByteStructType   *CorPtr;
   ByteStructType   *AmpPtr;
   ByteStructType   *PctPtr;
   ByteStructType   *SttPtr;

/*-----------------------------------------------------------------------*/

unsigned char RcvBuff[8192];


void DecodeBBensemble( void )
{
    unsigned short i, *IDptr, ID;

    FLdrPtr = (FixLeaderType *)&RcvBuff [ HdrPtr->Offset[0] ];

    if (FLdrPtr->NBins > 255)
        FLdrPtr->NBins = 32;

    for (i=1; i<HdrPtr->NDataTypes; i++)
    {
        IDptr = (unsigned short *)&RcvBuff [ HdrPtr->Offset [i] ];
        ID = IDptr[0];

        switch (ID)
        {
        case VLdrSelected:
            {
                VLdrPtr = (VarLeaderType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case VelSelected:
```

```
            {
                VelPtr = (IntStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case CorSelected :
            {
                CorPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case AmpSelected :
            {
                AmpPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case PctSelected :
            {
                PctPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case SttSelected :
            {
                SttPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        }
    }
}
```

15 Specifications

Table 34: Velocity Profiling (Broadband Mode) Specifications

	300kHz	600 kHz	1200 kHz
# Cells	1-128	1-128	1-128
Min. Cell size (cm)	100	50	25
Max. Cell size (cm)	1600	800	400
Max. Range (m)*	300	90	20
1st Cell start (m)	2-10	1-10	0.5 – 10
Accuracy			
(Cell=1/2 max.)	±0.5%	±0.5%	±0.5%
	± 0.2cm/s	± 0.2cm/s	± 0.2cm/s
Resolution (mm/s)	1	1	1
Velocity Range (m/s)	±5	±5	±5

Table 35: Transducer Specifications

Geometry	2 beams, ±20º beam angle
Beam Width	1.5º for 1200 kHz& 600 kHz, 2.2º for 300 kHz
Construction	Cast polyurethane with titanium hardware. Mounting plate included.

Table 36: Power Specifications

Voltage	10 to 18 VDC
Maximum Current	1.5A

NOTE. Energy consumption depends on velocity profiling parameters. Contact RD Instruments or a representative for an accurate prediction for your application.

Table 37: Standard Sensors Specifications

Acoustic Stage	Range	0.15 to 10 meters
	Accuracy	±0.1%, ± 3 mm (which ever is greater)
	Resolution	0.1 mm
Pressure	Range	0.1 to 10.5 meters
	Accuracy	± 26 mm
	Resolution	1.0 mm
Temperature	Range	-4º to 35ºC
	Accuracy	±0.2ºC
	Resolution	0.01º C
Tilt	Range	± 10°
	Accuracy	±0.2° @ 0°, ±0.5° @ 10°
	Resolution	0.01°

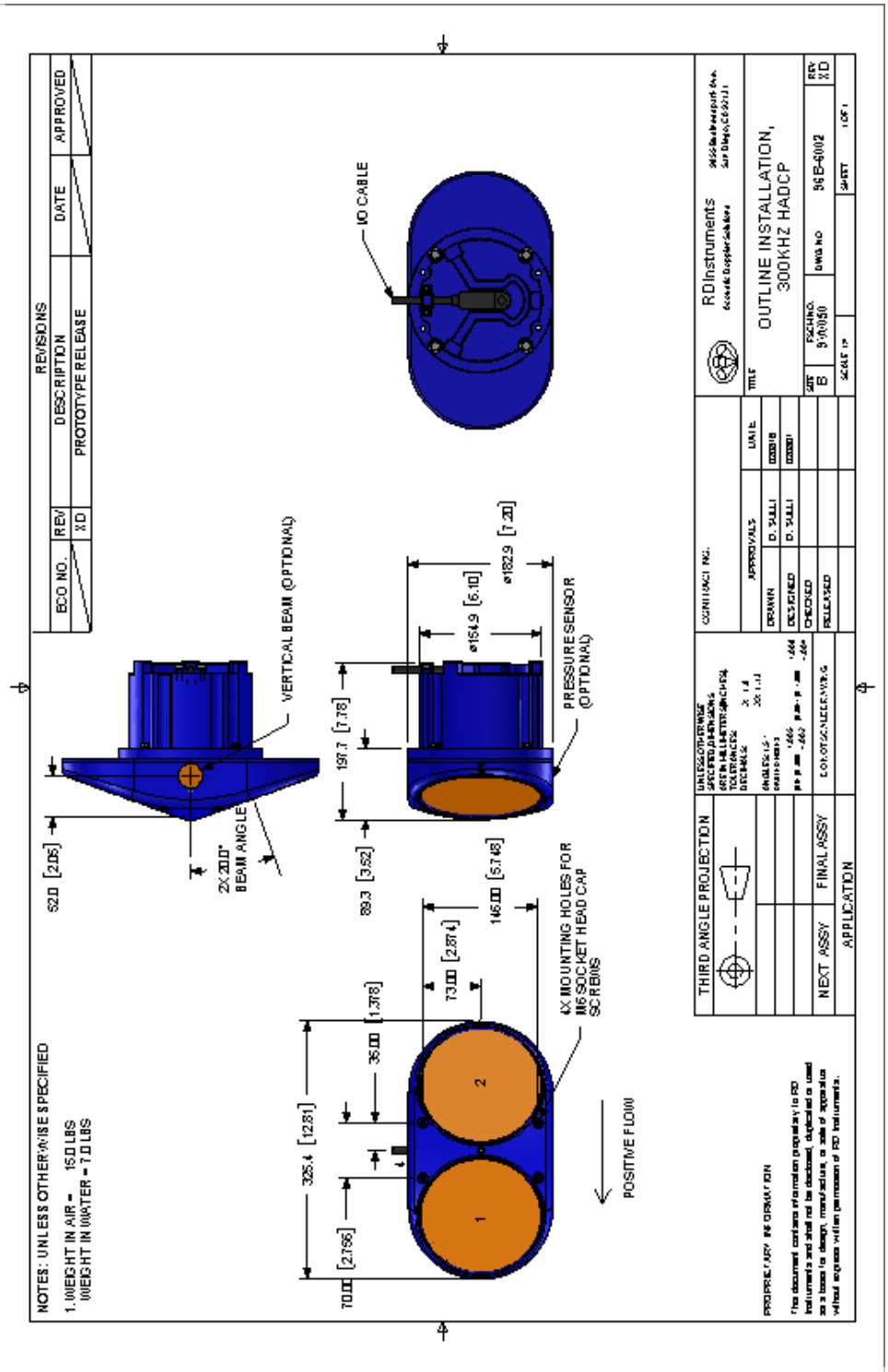
Table 38: Communications Specifications

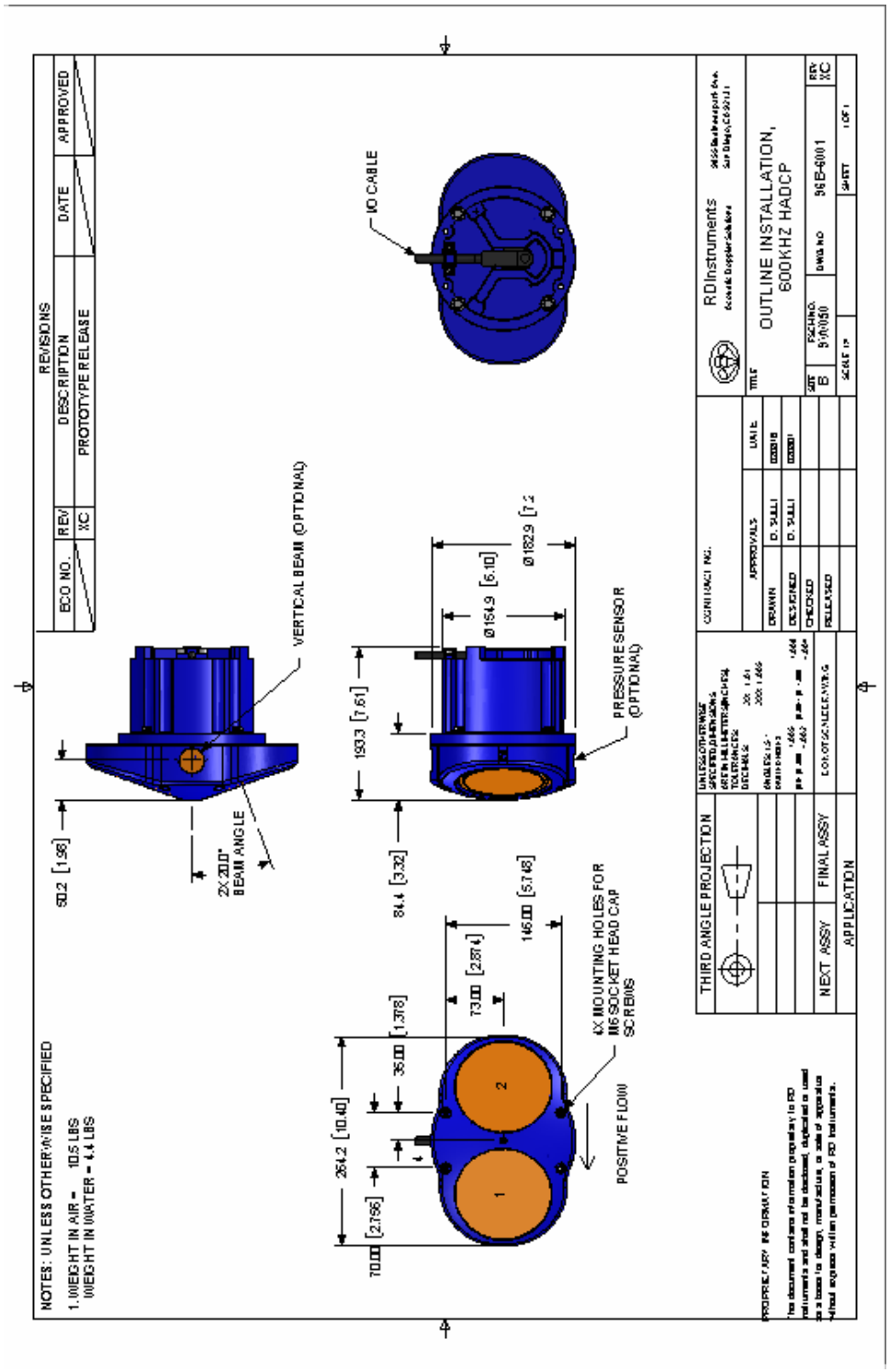
RS-232 with SDI-12, RS-422, RS-485

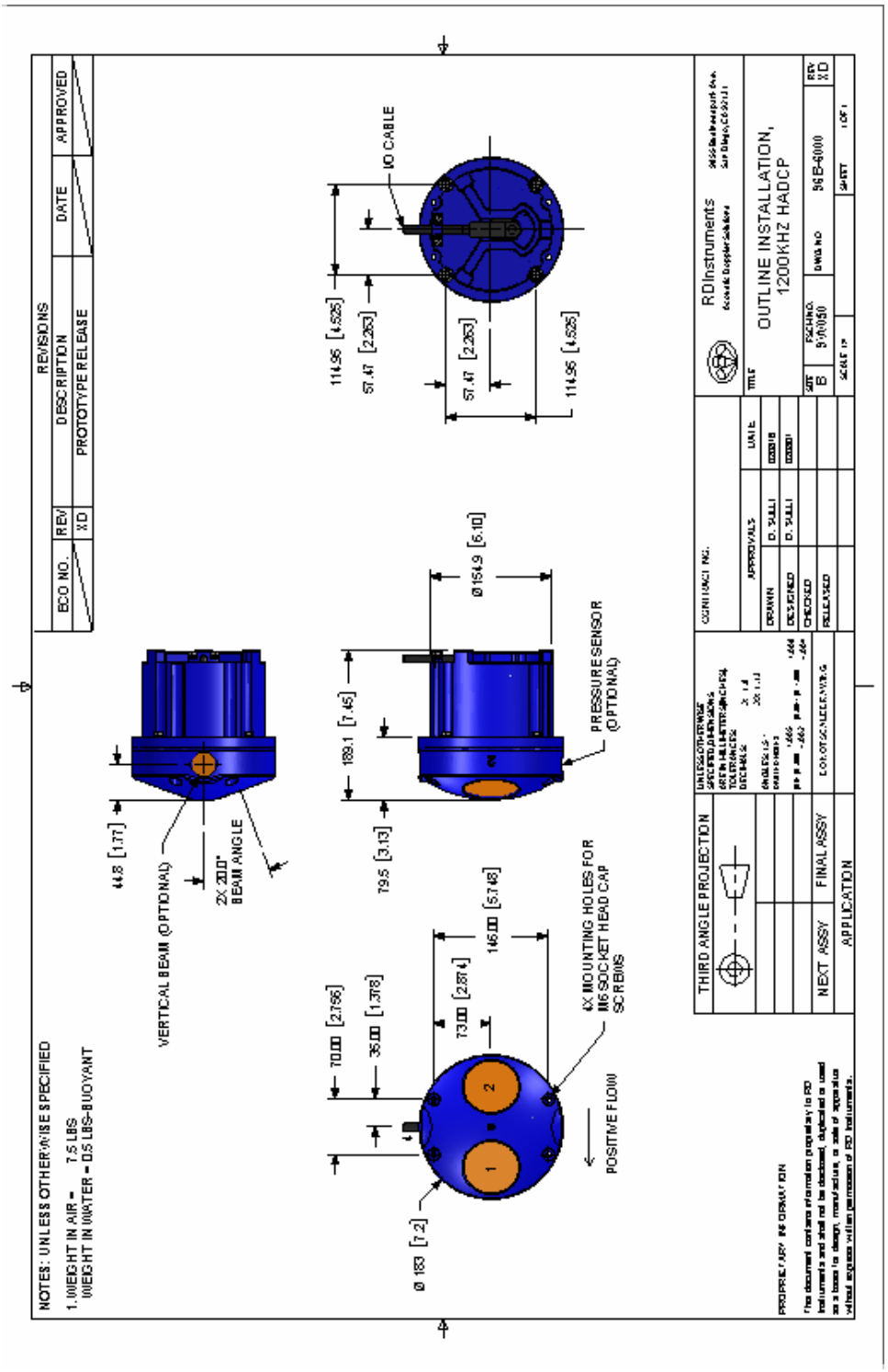
- SDI-12 supports v 1.3
- Simultaneous RS-232, SDI-12, and internal logging supported.

Serial Baud Rates: 300-115,200 bps

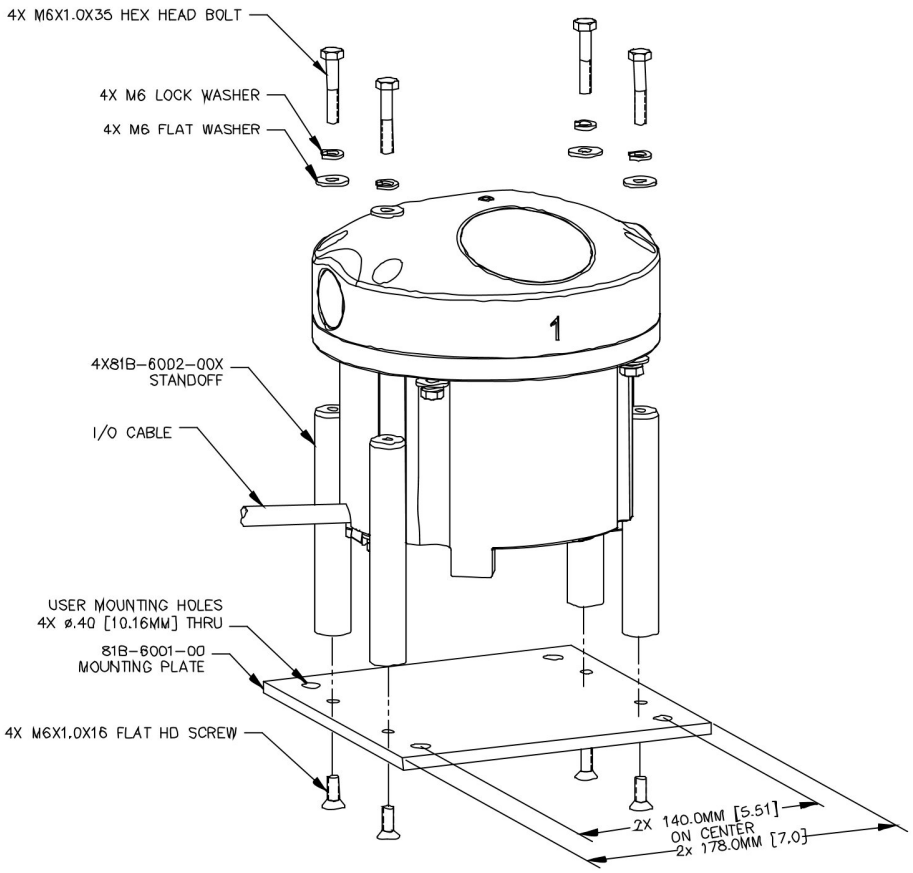
15.1 Outline Installation Drawings




REVISIONS
ECO NO.
REV
DESCRIPTION
DATE
APPROVED
XC
PROTOTYPE RELEASE
NOTES: UNLESS OTHERWISE SPECIFIED
1. WEIGHT IN AIR = 10.5 LBS
WEIGHT IN WATER = 4.4 LBS
VERTICAL BEAM (OPTIONAL)
2X 20.0° BEAM ANGLE
50.2 [1.98]
84.4 [3.32]
193.3 [7.61]
Ø154.9 [6.10]
Ø182.9
PRESSURE SENSOR (OPTIONAL)
I/O CABLE
264.2 [10.40]
70.0 [2.756]
35.0 [1.378]
73.0 [2.874]
146.0 [5.748]
4X MOUNTING HOLES FOR M5 SOCKET HEAD CAP SCREWS
POSITIVE FLOW
THIRD ANGLE PROJECTION
RDInstruments
OUTLINE INSTALLATION, 600KHZ HADCP
96B-0001
NEXT ASSY
FINAL ASSY
APPLICATION


NOTES: UNLESS OTHERWISE SPECIFIED
1. WEIGHT IN AIR = 7.5 LBS
WEIGHT IN WATER = 0.5 LBS-BUOYANT
REVISIONS
ECO NO.
REV
DESCRIPTION
DATE
APPROVED
XD
PROTOTYPE RELEASE
VERTICAL BEAM (OPTIONAL)
44.8 [1.77]
2X 20.0° BEAM ANGLE
79.5 [3.13]
189.1 [7.45]
Ø154.9 [6.10]
PRESSURE SENSOR (OPTIONAL)
70.00 [2.756]
35.00 [1.378]
73.00 [2.874]
146.00 [5.748]
4X MOUNTING HOLES FOR M6 SOCKET HEAD CAP SCREWS
POSITIVE FLOW
Ø 183 [7.2]
I/O CABLE
114.96 [4.525]
57.47 [2.263]
THIRD ANGLE PROJECTION
NEXT ASSY
FINAL ASSY
APPLICATION
RDInstruments
OUTLINE INSTALLATION, 1200KHZ HADCP
SIZE B
SCALE 1:2
SHEET 1 OF 1
REV XD

15.2 Mounting Plate Drawing



16 Technical Support

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments	**RD Instruments Europe**
9855 Businesspark Ave.	5 Avenue Hector Pintus
San Diego, California 92131	06610 La Gaude, France
(858) 693-1178	+33(0) 492-110-930
FAX (858) 695-1459	+33(0) 492-110-931
Sales - rdi@rdinstruments.com	rdi@rdieurope.com
Field Service – rdifs@rdinstruments.com	rdifs@rdieurope.com

Web: www.rdinstruments.com

After Hours Emergency Support - +1 858-578-0781

17 Glossary

If, after reviewing this section, you are unable to find the word/jargon in question, please **send us an e-mail** containing that word. Your questions will ensure that our glossary remains an effective reference tool for our customers.

------ A ------

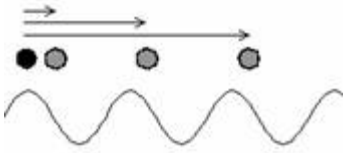
Acoustic Doppler Current Profiler (ADCP): An instrument that obtains profiles of water velocity by transmitting sound of known frequency into the water and measuring the Doppler shift of reflections from scatterers, which are assumed to be passively moving with the water.

Acoustic Window: A covering for the hull-side opening of a sea chest that is transparent to sound. A vessel mounted ADCP is typically mounted in a sea chest and the acoustic window helps to isolate it from biofouling organisms and also the flow noise generated by the vessel.

ADCP: Acoustic Doppler Current Profiler

ADCP Coordinates: Profile data is reported in an orthogonal coordinate system as referenced to the instrument. Beam 3 is forward. Sideways is to the right of forward (beam 2 for a down-looking ADCP, beam 1 for an up-looking ADCP).

Ambiguity: ADCPs determine the radial motion between a source and scatterer by measuring the phase change of the reflected signal. Because phase is periodic, this solution is multi-valued. For example, all three of the displacements shown below will return the same phase measurement, which results in ambiguity:



Ambiguity Resolution: A method to count the number of wavelengths included between two points where phase is measured, thereby removing the ambiguity associated with measuring only phase.

Ambiguity Velocity: The maximum allowable radial motion for phase measurements to be unambiguous, corresponding to a maximum observable velocity, beyond which ambiguity resolution is required.

Autonomous Underwater Vehicle (AUV): An unmanned submersible with propulsion, generally capable of navigation and accomplishing specific tasks (such as data gathering).

AUV: Autonomous Underwater Vehicle

------ B ------

Backscatter: 1) The portion of a sound wave that is reflected by scatterers directly back toward the source. 2) A qualitative measurement (in decibels) of scatterer concentration which is calculated in the WinRiver software. This calculation corrects the echo intensity data for sound absorption, beam spreading, transducer temperature, etc. and provides an excellent means of tracking relative concentration (e.g. "Is most of the sediment in the water here or is it there?"). Obtaining a quantitative measurement (e.g. "How many mg/L of bottom sediment are in this parcel of water?") requires a field calibration at the measurement site. There is a third-party software package, *Sediview*, designed for this task.

BBBatch: Utility program to allow automated conversion of a series of raw binary ADCP files to ASCII files.

BBCheck: Utility program that checks the integrity and quality of raw binary ADCP files.

BBConv: Utility program to convert some portion of a raw binary ADCP file into an ASCII file using a decoder file. Several decoder files are included on the RDI Tools CD, for example: extract only distance to first bin, extract only navigation data, etc. Complete documentation on these decoder files as well as information on how to write your own is available.

BBList: Utility program for viewing and converting raw binary ADCP data files. It is a menu-driven program offering a step-by-step process to convert raw binary files to ASCII files.

BBMerge: Utility program to convert comma-delimited ASCII files back into raw binary ADCP format.

BBSlice: A raw data sub-sectioning utility program. BBSlice converts a raw data file into a series of ASCII files, opening a new ASCII file whenever there is a jump in the sequence of ensemble numbers.

BBss: Utility program to calculate the speed of sound when given temperature, salinity and depth.

BBSub: A raw data sub-sectioning utility program. BBSub allows you to extract subsets of raw data from a large raw data file by choosing the starting and ending ensemble number.

BBTalk: Terminal emulator program for direct communication with the CPU of an ADCP or DVL.

Beam Angle: The angle between a transducer beam's main axis and the vertical axis of the ADCP or DVL (typically 20 or 30º).

Beam Coordinates: Profile data is reported as referenced along each beam (i.e. no coordinate transformation is performed upon the raw data).

Beam Spreading: The extent to which the main lobe of energy generated by a transducer fans out, or spreads as an acoustic wave front, with distance from the transducer. This is proportional to λ/d where λ is the wavelength of sound generated and d is the diameter of the transducer. Note: this is why ADCP transducer diameter increases with decreasing operating frequency (and increasing wavelength).

Bin (Depth Cell): A measurement within a profile, generally equivalent to a single-point current meter on a mooring.

Bin Mapping (Depth Cell Mapping): When the ADCP is tilted; the measurements taken at equal distances along each beam are no longer in the same horizontal layer of water. For example, in the image below the tilted ADCP bins do not line up horizontally, they are offset by one bin. In this case the tilted ADCP will offset the bins on the "right" beam by one bin in order to line them up horizontally with the bins on the "left" beam before combining the measurements to compute the velocity.

Blank Zone: The area near the head of an ADCP in which no measurements are taken. This is usually the minimum distance required to avoid collecting data that is potentially contaminated by ringing, but is sometimes extended for other reasons (e.g. to begin measurement well beyond the flow influence of a mounting structure).

Bottom Discharge: When using an ADCP to measure river discharge, it is not possible to measure all the way to the bottom (due to sidelobe contamination and the finite resolution of the depth cells). In order to get an accurate approximation of the total discharge, the flow in this area must be estimated and included, usually by extrapolating the measured velocities to the bottom using a power curve fit.

Bottom Track: In moving platform applications where the bottom is within range of the ADCP or DVL, a special ping can be transmitted to measure the Doppler shift of the signal return from the bottom. If the bottom is not moving, this measurement is a very accurate measurement of the platform velocity. For ADCPs this velocity is typically used to extract the true water velocity profile from the measured velocity profile (by removing the vehicle motion from the measurements). For DVLs, this IS the desired velocity.

Bottom Track Modes: There are currently four bottom tracking modes of operation available from RDI:

Bottom Mode 4: Uses ambiguity resolution, and adjusts lags for reduced variance at higher elevations (or deeper depths).

Bottom Mode 5: Specifically designed for reduced variance in shallow water/low elevations. It transmits several pings with computations to best determine depth and speed. This mode is the default mode, but it will automatically switch to Bottom Mode 4 if conditions warrant.

Bottom Mode 6: Offers special narrow bandwidth operation to reduce the potential for interference or for stealth. No ambiguity resolution, instead bottom mode 6 requires user input of an approximate operating elevation (or depth).

Bottom Mode 7: Similar to bottom mode 5, except that it is optimized for slow-moving platforms in very shallow, high backscatter environments.

Break: A wake up command to an ADCP or DVL that places the instrument in command mode.

Broadband ADCP: An ADCP that uses broadband processing.

Broadband Processing: Use of coded pulses to make multiple measurements of phase with a single ping, and thereby greatly increase the precision of the measurement.

------ C ------

Channel Master: Model name for an ADCP designed to use horizontal profiling for flow monitoring in inland waterways.

Command Mode: The state into which an ADCP or DVL goes upon receiving a break. In this mode the ADCP or DVL is waiting to receive a command. It draws relatively high power, so the ADCP or DVL will go to sleep if no command is received for five minutes.

Correlation: A key quality control parameter, this is essentially a measurement of how much the particle distribution has changed between phase measurements. The less the distribution has changed, the higher the correlation, and the more precise the velocity measurement.

------ D ------

Dead Reckoning: A navigation method where position is estimated by measuring velocity, heading and time from the last known position.

Degaussing: Technique used to remove the magnetic field from RDI battery packs before installation, done to minimize any effects the batteries will have on the magnetic compass.

Depth Cell (Bin): A measurement within a profile, generally equivalent to a single-point current meter on a mooring.

Depth Cell Mapping (Bin Mapping): When the ADCP is tilted; the measurements taken at equal distances along each beam are no longer in the same horizontal layer of water. For example, in the image below the tilted ADCP bins do not line up horizontally, they are offset by one bin. In this case the tilted ADCP will offset the bins on the "right" beam by one bin in order to line them up horizontally with the bins on the "left" beam before combining the measurements to compute the velocity.

DGPS: Differential Global Positioning System

Differential Global Positioning System (DGPS): Satellite-based navigation aid for precise measurement of location. When the bottom is out of range or moving, calculating the distance between DGPS position fixes and dividing by the time between those fixes can be used to measure the platform velocity.

Direct-Reading ADCP: An ADCP intended for real-time operation. Direct-Reading ADCPs do not have internal batteries or an internal recorder.

Discharge: The total flow through a section of a river. Rio Grande ADCPs obtain discharge measurements by transecting the river to measure water velocities, boat velocity, and the cross sectional area of the river and combining these measurements with estimates for the flow in the areas that can not be measured (edge estimates, bottom discharge and top discharge).

Distance Made Good: When measuring transects of data with a moving platform, this is a measure of the actual distance between the platform and the start point (i.e. variations in course track are removed).

Doppler Shift: Named for Johann Doppler (1803-1853), the German physicist who first predicted it: it is the shift in frequency caused by radial motion between a source and an observer. Specifically, $f_D = f_S (v/c)$: Where D is the Doppler-shifted frequency, f_S is the source frequency, v is the relative velocity between source and observer, and c is the speed of sound.

Doppler Velocity Log (DVL): An instrument designed to measure the velocity and elevation of a moving platform with bottom tracking. Most DVLs will switch to measuring velocity relative to the water when the bottom is out of range.

DVL: Doppler Velocity Log.

------ E ------

Earth Coordinates: Profile data is reported in an orthogonal coordinate frame as referenced to the Earth (East, North and Up). "North" can mean magnetic or true, depending on the heading input.

Echo Intensity: A key quality control parameter, echo intensity is a measure of the signal strength intensity returned to the transducer. High echo intensity can show solid targets (e.g. a boundary, obstruction or fish), while low echo intensity can show insufficient scatterers or the limits of profiling range for the environment.

Edge Estimate: When measuring river discharge with an ADCP it is not possible to measure to zero depth at the banks of the river. The flow through this unmeasured area must be approximated in order to obtain an accurate estimate of the total discharge.

Ensemble: A group of measurements (pings) considered together. An ensemble is usually the average of the individual measurements, and has a higher precision than any individual measurement.

Error Velocity: A key quality control parameter that derives from the four beam geometry of an ADCP. Each pair of opposing beams provides one measurement of the vertical velocity and one component of the horizontal velocity, so there are actually two independent measurements of vertical velocity that can be compared. If the flow field is homogeneous, the difference between these vertical velocities will average to zero. To put the error velocity on a more intuitive footing, it is scaled to be comparable to the variance in the horizontal velocity. In a nutshell, the error velocity can be treated as an indication of the standard deviation of the horizontal velocity measurements.

------ F ------

Fish Detection Threshold: Used to identify and mark as bad any velocity measurement that was potentially contaminated by a fish (because fish are generally not passively following the flow). It is a flag on the maximum allowable value for the measured echo intensity return.

Frequency: The number of wave crests passing a given point per unit time.

------ G ------

Gimbals: Frame that will support the weight of an object but allow its free rotation. Gimbals can be constructed to allow free rotation in one, two, or three axes.

Gyro: A rapidly spinning device mounted on gimbals to maintain a constant orientation. These devices are commonly used to measure heading on ships because, unlike magnetic compasses, they are unaffected by ferrous metals or by varying electromagnetic fields. They can also be used to measure pitch and roll because, unlike liquid level sensors, they are unaffected by accelerations.

------ H ------

Homogeneity: The extent to which the current measured by all four beams is the same. A key assumption of all ADCP processing is that the currents are horizontally homogeneous across the four beams. This assumption is checked for each measurement by using the error velocity measurement.

Horizontal ADCP (H-ADCP): Instrument designed to measure velocity profiles in a horizontal plane.

------ I ------

Inertial Navigation: Method for estimating the attitude and position of a moving platform (of primary interest here are AUVs) by integrating measurements from gyros and accelerometers. This integration is subject to large errors over time, so DVLs and pressure sensors are commonly incorporated as external inputs to measure and correct these errors.

------ J ------

------ K ------

------ L ------

Lag: A time delay between pulses or pings.

Long Ranger: Model name for Workhorse ADCPs of frequency 75 kHz.

Lowered ADCP (L-ADCP): Technique whereby one or two ADCPs are lowered through the water column (typically on a rosette) to obtain velocity profiles over the full ocean depth. Note that a whole body of research exists on how to properly remove the motion of the rosette from the velocity measurements obtained in this manner.

------ M ------

Main Lobe: The main focus of energy emitted from a transducer. If the transducer were a flashlight, the main lobe would be the visible beam of light.

Mariner: Model name for a Workhorse Monitor ADCP configured for underway current measurement in shallow water (as opposed to the deep water Ocean Surveyor systems).

Modes: RDI offers several modes of operation that are optimized for certain conditions. There are currently five modes of operation for water profiling available from RDI:

Mode 1: General purpose water profiling. This is the most robust profiling mode, designed for the widest variety of measurement applications. Mode 1 can resolve high velocities and can measure over long ranges.

Mode 5: For high resolution profiling in shallow water with low flows. Mode 5 should be used with bottom tracking. It offers the lowest standard deviation per measurement, but is also the most limited in its allowed performance envelope (e.g. low velocity flow, slow platform movement, no high shears or turbulence).

Mode 8: Also for high resolution profiling in shallow water. Mode 8 should also be used with bottom tracking. It has higher standard deviation per measurement than mode 5, but allows a somewhat wider performance envelope.

Mode 11: The latest in our high resolution profiling modes. Intended for the shallowest water, it is also well suited for boundary layer studies. Mode 11 should be used with bottom tracking. It allows smaller depth cells (1 cm), more depth cells, and has improved signal processing which allows faster ping rates and a wider performance envelope than modes 5 and 8. Mode 11 is intended to supercede mode 5.

Mode 12: Offers increased resolution (1 cm depth cells) and uses multiple sub-pings to improve the standard deviation of each measurement. Mode 12 allows measurement of fast moving, shallow water; and can also be used to improve the standard deviations of any measurement (any range, any velocity) when the ADCP heading is fixed or reasonably steady.

Monitor: Model name for a direct reading Workhorse ADCP.

Moving Bottom: Some rivers carry such a heavy sediment load that they do not have a clearly identifiable bottom. In essence, the mud just keeps getting thicker and slower with depth. In such environments it is not un-

common for bottom tracking measurements to lock onto a sediment layer that is still moving, resulting in a bias to the bottom tracking velocity. This is especially important for river discharge measurements, where the vessel's navigation must be substituted for the bottom track velocity to obtain accurate results.

------ N ------

Navigator: Model name for the RDI Doppler Velocity Log.

Narrowband ADCP: An ADCP that uses narrowband processing.

Narrowband Processing: Uses a single pulse per ping to measure velocity. The lack of coding in the pulse makes a narrowband measurement much less precise, but it allows profiling over a longer range. Narrowband processing generally requires much larger ensembles to get a precise measurement.

------ O ------

Ocean Observer: Low frequency Phased Array ADCP for cabled deployment, usually from an oilrig.

Ocean Surveyor: Low frequency Phased Array ADCP for vessel-mounted operations.

------ P ------

Percent Good: A key quality control parameter, percent good indicates what fraction of the pings passed the various error thresholds. Each depth cell reports four values for percent good, and the meaning depends on the coordinate frame. If data is collected in beam coordinates, then the four percent good values represent the percentage of the pings collected by each beam for that depth cell whose correlation exceeded a low correlation threshold. In the other coordinate frames (ADCP, Ship and Earth Coordinates), the four Percent Good values represent (in order): 1) The percentage of good three beam solutions (one beam rejected); 2) The percentage of good transformations (error velocity threshold not exceeded); 3) The percentage of measurements where more than one beam was bad; and 4) The percentage of measurements with four beam solutions.

Phase: An engineering measure of the propagation delay caused by radial motion between scatterer and source. Phase is ambiguous in that it is cyclical (e.g. 10 º is the same phase as 370 º).

Phased Array Transducer: A single, flat, multi-element transducer that uses an RDI proprietary technique to simultaneously form all four beams. Available phased array transducers are generally low frequency (38 kHz, 75 kHz and 150 kHz) long range devices.

Ping: The entirety of the sound generated by an ADCP transducer for a single measurement cycle. A broadband ping contains a coded series of pulses and lags, while a narrowband ping contains a single pulse.

Ping Mode: Power conserving mode for a deployed ADCP or DVL, where only the power needed for the immediate deployment task is drawn (as opposed to command mode, where the ADCP consumes considerable power while simply waiting for input). This mode saves the deployment configuration so that, in the event of a power interruption, the ADCP or DVL will be able to automatically resume the configured deployment upon return of power.

PlanADCP: Windows-based software package allowing the user to configure, and evaluate the consequences of, a deployment command-set for an ADCP.

Profile: A series of regularly spaced depth cells in which the ADCP measures velocity along with several quality control parameters.

Pulse: A sound wave generated by a transducer.

Propagation Delay: The change in the travel time of sound between a source and scatterer, generally due to radial motion. As an example: if it takes longer for sound to reflect back from a scatterer than it did a short while ago (and the speed of sound has not changed), then the scatterer must be getting farther away.

------ Q ------

------ R ------

Radial Motion: Movement which alters the distance between source and scatterer.

Range: The maximum profile length of an ADCP, it depends on several factors (note that these factors are inter-related in a complex way, and the generalizations below are intended only as rules of thumb – use PlanADCP to check specific combinations):

1. Frequency: the lower the frequency, the longer the range.
2. Depth cell size: the larger the cell, the longer the range.
3. Mode of operation: mode 1 has the longest range.
4. Bandwidth: the narrower the bandwidth, the longer the range.
5. Concentration of scatterers: generally, the more scatterers, the longer the range.
6. Temperature: generally, the colder the water, the longer the range.

7. Salinity: generally, the fresher the water, the longer the range.

Range Gating: After sending a ping into the water, the ADCP transducers listen for returned signal. The time series of the returned signal is then broken into a sequence of time segments, or range gates. Each segment is equivalent to a depth cell, with the last segment coming from the farthest range from the ADCP.

RDI Tools: Software package containing all of the BB* programs (*BBTalk*, *BBList*, etc.) as well as several commonly used decoder files.

Reference Layer: In moving platform applications where the bottom is out of range, the vessel motion can be approximated by assuming the water is motionless at some point in the measured profile. This point is the reference layer.

Remotely Operated Vehicle (ROV): unmanned submersible controlled by an operator via a tethering cable.

Ringing: After transmission the ADCP electronics, transducer and immediate surrounding equipment (particularly in vessel mounted ADCPs) all require some finite time to dampen the transmit energy, during which time any signal return from scatterers will be contaminated.

Rio Grande ADCP: The model name for an ADCP optimally configured for measurement of river discharge. A distinguishing feature of Rio Grande ADCPs is that they are designed to operate from a 12 VDC power supply (all other ADCPs operate from 20 – 50 VDC).

Rosette: Oceanographic instrumentation package found on most research vessels. Rosettes are designed to be lowered to depths of interest while collecting data of various types. Most Lowered-ADCPs are mounted on rosettes.

ROV: Remotely Operated Vehicle

------ *S* ------

Scatterers: Small particles or plankton in the water which reflect sound waves.

Sea Chest: Cavity in the hull of a vessel to allow stream-lined, recessed mounting of equipment such as a Vessel Mount ADCP.

Sediview: Third party software designed to use ADCP echo intensity measurements and *in situ* sampling to obtain quantitative estimates of sediment concentration.

Self-Contained ADCP: An ADCP equipped with internal batteries and an internal recorder for autonomous operation.

Sentinel: The model name for a self-contained Workhorse ADCP.

Ship Coordinates: Profile data is reported in an orthogonal coordinate frame as referenced to the ship (if beam 3 is forward then ship coordinates are the same as instrument coordinates).

Sidelobes: Peaks in sound intensity generated by a transducer found to the side of the main lobe.

Sidelobe Contamination: This only need be considered when operating an ADCP near a boundary (e.g. in shallow water). The beam angle of the main lobe of an ADCP transducer is 20 or 30º off the vertical, which means that the distance to the boundary along the ADCP centerline is shorter than the distance to the boundary along a beam. Because most boundaries will reflect very strongly (much more strongly than the scatterers), sidelobe energy can travel the shorter path directly to the surface and thereby include the "velocity" of the boundary with the velocity measurements taken along the beams at any longer distance. This potential for interference depends strictly on the beam angle. An ADCP with a 20º beam angle has the potential for sidelobe contamination at (distance to the boundary)*cos(20º), or equivalently, the last 6% of the profile. Note: Sidelobe contamination is not relevant for DVLs, which specifically look for the bottom.

Software Break: When using radio or acoustic telemetry, it is usually not possible to send a break signal. Under these circumstances an ADCP can be configured to recognize a series of keystrokes (i.e. = = =) as a break.

Source: Originator of sound of known frequency, here typically the transducer of an ADCP.

StreamPro: Model name for ADCP designed for discharge measurement in shallow waterways.

------ T ------

Top Discharge: When using an ADCP to measure river discharge, it is not possible to measure all the way to the surface (due to the blank zone and to the need to mount the transducers at sufficient depth to remain submerged with no air entraining past the transducers). In order to get an accurate approximation of the total discharge, the flow in this area must be estimated and included, usually by extrapolating the measured velocities to the surface.

Transducer: A device to convert electrical energy into sound waves, and vice versa.

------ U ------

Unmanned Underwater Vehicle (UUV): Generic term referring to both AUVs and ROVs.

UUV: Unmanned Underwater Vehicle

------ V ------

Vessel Mount: An ADCP mounted to the hull of a vessel, typically in a sea chest, and having inputs from the vessel's navigation equipment.

VM-DAS: Windows-based data acquisition package for vessel mount ADCPs. This package includes the ability to incorporate the ship's navigation equipment.

------ W ------

Wavelength: The distance between successive wave crests in a sound wave.

WinADCP: Windows-based post-processing package for ADCP data.

WinH-ADCP: Windows-based data acquisition and playback package for Horizontal ADCPs.

WinRiver: Windows-based software package for real time ADCP data gathering. It is designed primarily for measurement of river discharge and allows integration of the platform's navigation equipment. It also converts echo intensity measurements to qualitative estimates of backscatter.

WinSC: Windows-based software package for self-contained ADCPs includes configuring, testing, data recovery and viewing options.

Workhorse ADCP: The generic model name for all of the non-phased array broadband ADCPs currently produced by RDI.

------ X ------

Xdcr: A common abbreviation for transducer.

------ Y ------

------ Z ------

ZedHed: RDI trade name for a transducer designed to minimize ringing.

NOTES

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